# SELECTED

# **SOURCES**RESOURCES ABSTRACTS



VOLUME 24, NUMBER 11 NOVEMBER 1991

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# SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey U.S. Department of the Interior

VOLUME 24, NUMBER 11 NOVEMBER 1991

W91-10469 -- W91-11600



As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

#### PREFACE

S elected Water Resources Austracts, journal, includes abstracts of current and earlier reports, and elected Water Resources Abstracts, a monthly pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the Water Resources Thesaurus. The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific Information Center U.S. Geological Survey MS 425 National Center Reston, VA 22092

#### CONTENTS

#### SUBJECT FIELDS AND GROUPS

Please use the edge index on the back cover to locate Subject Fields and Indexes.

01 NATURE OF WATER

Includes the following Groups: Properties; Aqueous Solutions and Suspensions.

02 WATER CYCLE

Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

04 WATER QUANTITY MANAGEMENT AND CONTROL

Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Nonwater Activities; Watershed Protection.

05 WATER QUALITY MANAGEMENT AND PROTECTION

Includes the following Groups: Identification of Pollutants; Sources of Pollution; Effects of Pollution; Waste Treatment Processes; Ultimate Disposal of Wastes; Water Treatment and Quality Alteration; Water Quality Control

06 WATER RESOURCES PLANNING

Includes the following Groups: Techniques of Planning; Evaluation Process; Cost Allocation, Cost Sharing, Pricing/Repayment; Water Demand; Water Law and Institutions; Nonstructural Alternatives; Ecologic Impact of Water Development.

07 RESOURCES DATA

Includes the following Groups: Network Design; Data Acquisition; Evaluation, Processing and Publication.

08 ENGINEERING WORKS

Includes the following Groups: Structures; Hydraulics; Hydraulic Machinery; Soil Mechanics; Rock Mechanics and Geology; Concrete; Materials; Rapid Excavation; Fisheries Engineering.

09 MANPOWER, GRANTS, AND FACILITIES

Includes the following Groups: Education—Extramural; Education—In-House; Research Facilities; Grants, Contracts, and Research Act Allotments.

10 SCIENTIFIC AND TECHNICAL INFORMATION

Includes the following Groups: Acquisition and Processing; Reference and Retrieval; Secondary Publication and Distribution; Specialized Information Center Services; Translations; Preparation of Reviews.

SUBJECT INDEX

**AUTHOR INDEX** 

ORGANIZATIONAL INDEX

**ACCESSION NUMBER INDEX** 

#### SELECTED WATER RESOURCES ABSTRACTS

#### 2. WATER CYCLE

#### 2A. General

ESCCP CLOUD DATA PRODUCTS. National Aeronauties and Space Administration, New York. Goddard Inst. for Space Studies. For primary bibliographic entry see Field 2B. W91-10479

HYDROLOGICAL ASPECTS OF THE 1988 DROUGHT IN ILLINOIS.
Illinois State Water Survey Div., Champaign. Climatology and Meteorology Section. For primary bibliographic entry see Field 2B. W91-10810

HYDROLOGICAL BALANCE OF TWO MEDITERRANEAN FORESTED CATCHMENTS (PRADES, NORTHEAST SPAIN).

URAJDES, NURIHEAST SPAIN).
Barcelona Univ. (Spain). Dept. de Ecologia.
J. Pinol, M. J. Lledo, and A. Escarre.
Hydrological Sciences Journal HSJODN, Vol. 36,
No. 2, p 95-107, April 1991. 5 fig, 4 tab, 24 ref.
EEC grant EV4V-0109-E.

Descriptors: \*Evapotranspiration, \*Forest water-sheds, \*Model studies, \*Rainfall-runoff relation-ships, \*Soil-water-plant relationships, \*Spain, Arid-zone hydrology, Mediterranean, Precipitation.

Arid and semiarid areas have some hydrological features that make the modeling of rainfall-runoff processes difficult, such as the acute scarcity of precipitation and streamflow data, and the great rainfall variability. Precipitation and discharge have been measured for several years in two small forested catchments located in the Mediterranean area of Spain, where water fluxes have been conarea of Spain, where water fluxes have been considered as a major aspect of vegetation growth and sustainability as well as a vector for nutrient transport to and across the ecosystem. Actual evapotranspiration has been calculated as the difference between annual precipitation and discharge. Results show that: (1) most of the precipitation is evaporated rather than lost by streamflow, even in the most humid years: (2) there is a high interanevaporated rather than lost by streamflow, even in most humid years; (2) there is a high interannual variability both in discharge and evapotranspiration; and (3) annual evapotranspiration correlates significantly with annual precipitation, in contrast to the constancy of annual evaporation in catchments of wet, colder climates. Finally, a simple expression has been proposed in order to calculate annual actual evaporation from the ratio of precipitation to potential evapotranspiration. This expression uses a derived exponent which takes into account the characteristics of individual catchments. (Author's abstract) catchments. (Author's abstract) W91-10963

EFFECTS OF CLIMATE CHANGE ON DIS-CHARGES AND SNOW COVER IN FINLAND. National Board of Waters, Helsinki (Finland). Water Research Inst. For primary bibliographic entry see Field 2C. W91-10964

MAXIMUM ENTROPY VIEW OF PROBABILI-TY-DISTRIBUTED CATCHMENT MODELS, Heriot-Watt Univ., Edinburgh (Scotland). Dept. of Civil Engineering.

P. W. Jowitt. Hydrological Sciences Journal HSJODN, Vol. 36, No. 2, p 123-134, April 1991. 2 fig, 13 ref.

Descriptors: \*Catchment areas, \*Hydrologic models, \*Model studies, \*Probability distribution, \*Rainfall-runoff relationships, \*Runoff forecasting, \*Watersheds, Reservoir storage.

The spawning of a plethora of catchment models and spawning or a pietnora of catchment models of increasing and arbitrary complexity has been driven by the need for a more accurate representation of catchment response. The probability-distributed catchment model, as originally proposed by Moore & Clark in 1981, was re-examined from a maximum statistical entropy vianaging. The distributions of the control of th aximum statistical entropy viewpoint. The distri-

bution of water within a catchment was treated as a problem of statistical inference and resolved using an entropy maximization technique. A simple trunoff generating mechanism was employed, which, together with the catchment mass balance equation, yields a catchment model involving just equation, yields a catchment model involving just one dynamic parameter, y, and two constants, k and lambda. The parameter y determines the temporal variation of catchment storage V and runoff q. The runoff q is nonlinearly related to V through q = k(1-(lambda)yV), where y provides the nonlinear departure from the simple linear reservoir q=kV. (Author's abstract) W91-10965

RUNOFF ANALYSIS OF THE CHANG JIANG (THE YANGTZE RIVER).

6-13-30 Mihamai Karasuyama, Sebagaya-ku, Tokyo 157, Japan. For primary bibliographic entry see Field 2E. W91-10966

DYNAMIC-STOCHASTIC MODELS OF RAIN-FALL AND SNOWMELT RUNOFF FORMA-TION.

Akademiya Nauk SSSR, Moscow. Inst. Vodnykh

L. S. Kuchment, and A. N. Gelfan. Hydrological Sciences Journal HSJODN, Vol. 36, No. 2, p 153-169, April 1991. 12 fig, 2 tab, 13 ref.

Descriptors: \*Flood forecasting, \*Flood frequency, \*Hydrologic models, \*Model studies, \*Rainfall-runoff relationships, \*Snowmelt, \*Stochastic models, Dynamic programming, Maximum probable floods, Monte Carlo method, Numerical analysis, Rainfall, Soviet Union

In many cases observed runoff data are too scarce In many cases onserved runor data are too scarce or nonhomogeneous to determine flood frequen-cies with sufficient reliability using statistical anal-ysis of discharge series. Possibilities for the devel-opment of dynamic-stochastic models of runoff formation with random inputs have been exam formation with random inputs have been examined.

Two models were investigated: the first allows the calculation of the statistical distribution of the maximum discharges of rainfall floods, and the second the statistical distribution of snowmelt volumes.

The rainfall flood formation model was applied to the Coloragin being in the LISES which was the coloragin being the the Golovesnia basin in the USSR, which was schematized as a series of four rectangular reaches each described by the kinematic wave equations and numerically integrated. Most of the parameters were determined from observed data. Runoff hy-drographs for 380 seasons (541 floods) were simudrographs for 380 seasons (541 floods) were simulated, taking into account correlation between input values, and satisfactory agreement was found between the observed and calculated exceedance probabilities. The snowmelt runoff formation model used meteorological inputs generated by the Monte Carlo method and physically-based models for the transformation of input data into runoff. Model verification was carried out for the Sosna River basin in the USSR, characterized by a large variability of groupment runoff, infiltration, and variability of snowmelt runoff, infiltration, and frozen soils. Numerical experiments on the estimafrozen soils. Numerical experiments on the estima-tion of the sensitivity of model-computed results to changes of the model parameters showed that re-sults largely depend on the saturated hydraulic conductivity and an empirical parameter. It was concluded that application of the Monte Carlo method combined with numerical methods of solv-ing differential equations describing dynamic proc-esses in hydrological systems leads to a substantial growth in the number of calculations; however, the increased capabilities of modern computers make this restriction less important. (Fish-PTT) W91-10967. W91-10967

DYNAMIC SIMULATION MODEL OF VERTI-CAL INFILTRATION OF WATER IN SOIL. Gosudarstvennyi Gidrologicheskii Inst., Leningrad

V. Y. Grigorjev, and L. Iritz. Hydrological Sciences Journal HSJODN, Vol. 36, No. 2, p 171-179, April 1991. 3 fig, 1 tab, 18 ref.

Descriptors: \*Hydrologic models, \*Infiltration, \*Model studies, \*Rainfall forecasting, \*Rainfall-runoff relationships, \*Soil water, Aeration zone,

Excess rainfall, Hydraulic gradient, Rainfall rate, Soil profiles, Storm seepage, Surface runoff.

One of the most important problems of hydrological forecasting is to obtain a reliable estimation of effective rain. Infiltration is one of the variables which greatly influences the partitioning of rainfall into surface runoff and subsurface flow. An infliration model has been developed which describes the unsaturated zone as a multilayer system. For the unsaturated zone as a multilayer system. For this purpose, a relationship previously developed for total hydraulic potential versus soil moisture content has been used. The model contains a system of ordinary differential equations for describing soil moisture movement, and it can be scriong soil moisture movement, and it can be interpreted as an aggregated simulation model with lumped parameters. The model was used to measure the dependence of computed excess rain on the homogeneity/inhomogeneity of the soil profile and on the number/thickness of soil layers. With a given rainfall rate, excess rainfall was simulated on unlayered and layered homogeneous soil profiles. The infiltration was stabilized at different levels for 1.5 h in all three cases but the number/thickness of 1.5 hi all three cases but the number/thickness of layers strongly affected the calculated volume of excess rainfall. Excess rainfall appeared first on the profile divided into a maximum of ten layers and last on homogeneous soil. The excess rain on average for a soil with five layers is twice as high as on the unlayered soil, and 2.5 times higher on ten layers of soil than on five. With the rainfall rate, excess rainfall was simulated on a homogeneous and an inhomogeneous soil profile. In the case of the inhomogeneous profile, the second layer in the unsaturated zone had low conductivity. The excess rainfall on the inhomogeneous profile turned out to unsaturated zone had low conductivity. The excess rainfall on the inhomogeneous profile turned out to be twice as high as on the homogeneous one. With an increased number of layers, the model has a finer control over the soil moisture redistribution and hydraulic gradients. As a consequence, the gradient profile becomes 'smoother' and the infiltration rate decreases (the rainfall excess increases). W91-10968

VARIATION OF MOISTURE CONDITIONS IN

CHINA DURING THE LAST 2000 YEARS.
State Univ. of New York at Stony Brook. Inst. for Terrestrial and Planetary Atmospheres.

G. Gong, and S. Hameed. G. Gong, and S. Hameed. International Journal of Climatology UCLEU, Vol. 11, No. 3, p 271-283, April 1991. 7 fig. 3 tab, 20 ref. CO2 Research Division, Office of Basic Energy, US Department of Energy Grant DEFG0285ER60314A007.

Descriptors: \*China, \*Climatic changes, \*Climatology, Climatic data, Climatic zones, Drought, Floods, Meteorological data, Moisture, Precipita-

Utilizing more than 50,000 reports of droughts and floods found in local records, the history of moisture conditions in eastern China has been reconstructed for the last 2000 years. The area studied extends eastward of Gansu province and is situated between Inner Mongolia in the north and Zhejiang in the south. Separate analyses were made for the semi-arid, semi-wet, and wet subdivisions of this area. It was possible to develop moisture indices with a time resolution of 5 years in each subregion. The time series of the moisture index for the semi-The time series of the moisture index for the semi-wet area extends over the period AD 1-1950, while for the other two subregions the period covered is AD 251-1950. Each of the climatic subdivisions was found to undergo prolonged periods of dry-ness and wetness. The frequency of alternation between dry and wet conditions increased from the semi-arid region to the semi-wet regions to the wet region. The variations of moisture conditions in the whole area of eastern China was compared with the known changes in the level of the Caspian Sea. The variations in the two regions were found to be similar on the time-scale of centuries. (Author's abstract) W91-10971

COMPARISON OF MEAN ANNUAL RUNOFF ESTIMATES IN THE CANADIAN PORTION OF THE GREAT LAKES BASIN.

#### Group 2A-General

Environment Canada, Guelph (Ontario). Water Resources Branch.
For primary bibliographic entry see Field 2E.

EFFECTS OF THE 1988 DROUGHT ON WATER RESOURCES IN WISCONSIN. For primary bibliographic entry see Field 2E. W91-11108

#### METHOD OF COMPILING WATER-MANAGE-MENT BALANCES.

A. S. Reznikovskii. Hydrotechnical Construction HYCOAR, Vol. 24, No. 6, p 411-417, December 1991. 5 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, pp. 38-42, June, 1990.

Descriptors: \*Hydrologic budget, \*Regional analysis, \*Soviet Union, \*Water supply, Regional development, Water consumption, Water resources de-

The Soviet Union has one of the world's greatest total supplies of water, but the specific average runoff (per unit area) is 1.5 times lower than in China, 2 times lower than in the USA, and 2.4 times lower than in France. Adequate supplies of clean water are beginning to become a factor in the continued economic development of certain parts continued economic development of certain parts of the country. To determine the future water supplies available to consumers at given levels of development of the economy, it is necessary to compile water-management balances. The method of compiling water-management balances still remains the subject of discussion by water managers developing water resources schemes. On the basis of the balances for a given region, the region can be divided into non-deficit regions, low-deficit regions, and acutely deficit regions. gions, deficit regions, and acutely deficit regions. Even in well-watered areas of the country, there are some limited areas where provision of water for even existing consumers may be very difficult. The water-management balance consists of two The water-management balance consists of two elements: income (surface and subsurface waters, return and waste waters) and outgo (water consumers, water users, and losses). Each of these elements has a certain annual volume, which varies year by year and has a certain level of reliability. The income portion of the water-management balance includes only that water than can be used ance includes only that water than can be used practically in economic activities. The outgo portion includes both uses of water (e.g., hydropower) and nonreturnable consumption (e.g., evapotranspiration). Ultimately, the water balance can be adjusted to the real situation by determining the sum of all positive and negative differences from a balance throughout the year. If the negative differ-ences are in excess, the region is a deficit region and plans must be made for river regulation, reduction of consumption, or importing water to achieve a balance. (Rochester-PTT) a balance. ( W91-11293

#### HYDROLOGIC SCIENCE: A DISTINCT GEO-SCIENCE

Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering. P. S. Eagleson.

Reviews of Geophysics RVGPB4, Vol. 29, No. 2, p 237-248, May 1991. 8 fig, 1 tab, 9 ref, append.

Descriptors: \*Earth-water interfaces, \*Hydrologic cycle, \*Hydrology, \*Research priorities, \*Reviews, Atmosphere, Data acquisition, Dissolved solids, Ecosystems, Education, Glaciers, Ice, Institutions, Lakes, Oceans, Remote sensing, Rivers,

Hydrologic science deals with the occurrence, distribution, circulation, and properties of water on Earth. It is clearly a multidisciplinary science, as through the hydrologic cycle water is important to and affected by physical, chemical, and biological processes within all the compartments of the Earth system: atmosphere, glaciers and ice sheets, solid earth, rivers, lakes, and oceans. Because of this geophysical ubiquity, and because water is necessary and limiting for life, concern for issues of hydrologic science has been distributed among the traditional geoscience and engineering disciplines. As a result, an infrastructure of hydrologic science (i.e., a clear identity, with supporting educational programs, research grant programs, and research institutions) has not developed, and a coherent understanding of water's role in the planetary-scale behavior of the Earth system is missing. The National Research Council Committee on Opportunities in the Hydrologic Sciences has assessed the status of understanding in the following components of the hydrologic sciences: reservoirs and fluxes of water, space and the Earth's mantle, oceans and atmosphere, the hydrological cycle, the Earth's crust, ice, the flux of sediments and dis-solved solids, and the involvement of biota. Five research areas seem to offer the greatest expected contribution to the understanding of hydrologic science: (1) chemical and biological components of steinless (1) cliential and obligated components of the hydrologic cycle; (2) scaling of dynamic be-havior; (3) land surface-atmosphere interactions; (4) coordinated global-scale observation of water reservoirs and the fluxes of water and energy; and (5) hydrologic effects of human activity. (Medina-W91-11429

#### POINT-INFILTRATION MODEL FOR ESTI-MATING RUNOFF FROM RAINFALL ON SMALL BASINS IN SEMIARID AREAS OF WYOMING.

For primary bibliographic entry see Field 2E. W91-11585

#### CHARACTERIZATION AND SIMULATION OF RAINFALL-RUNOFF RELATIONS FOR HEADWATER BASINS IN WESTERN KING AND SNOHOMISH COUNTIES, WASHING-TON.

Geological Survey, Tacoma, WA. Water Resources Div. R. S. Dinicola.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4052, 1990. 52p, 21 fig, 7 tab, 21 ref.

Descriptors: \*Computer models, \*Headwaters, \*Model studies, \*Rainfall-runoff relationships, \*Simulation analysis, \*Washington, Computer programs, Flood peak, Performance evaluation, Seasonal variation, Storm runoff.

The characteristics of rainfall-runoff relations were hypothesized for the study area as a whole by using existing information. In undisturbed areas, shallow-subsurface flow from hillslopes mantled with glacial till, groundwater flow from glacial outwash deposits, and saturation overland flow from depressions, stream bottoms, and till-capped hilltops are the important runoff mechanisms. In disturbed, primarily urban areas, Horton overland flow, which is runoff generated from rain falling at a greater rate than the infiltration rate of the soil, is a significant mechanism, along with overland flow from impervious surfaces. These hypothesized characteristics were incorporated into the Hydro-logic Simulation Program-FORTRAN (HSPF) simulation model, and the model was calibrated concurrently at 21 stream gage sites in the study area with hydrologic data from the 1985-86 water years. The calibration resulted in 12 sets of generalized HSPF parameters, one set for each land-segment type with a unique hydrologic response. The generalized parameters can be used with HSPF to simulate runoff from most headwater basins within the study area. The average standard errors of estimate for calibrated streamflow simulation at all 21 sites were 7.9% for annual runoff, 11.2% for winter runoff, 13.11% for spring runoff, 40.1% for summer runoff, 21.7% for storm peak discharge, 21.4% for storm runoff volume, and 42.3% for all daily mean discharges. High flows were simulated more accurately than were low flows. The simulation errors were not large enough to reject the hypothesized rainfall-runoff relations. (Author's abstract) W91-11592

#### 2B. Precipitation

# INCREASED PRECIPITATION ACIDITY IN THE CENTRAL SIERRA NEVADA. California Univ., Davis. Div. of Environmental

Studies.

For primary bibliographic entry see Field 5B. W91-10471

#### ANALYSIS OF PRECIPITATION CHEMISTRY MEASUREMENTS IN SHIMANE, JAPAN.

Shimane Prefectural Inst. of Public Health and Environmental Science, Matsue (Japan). K. Yamaguchi, T. Tatano, F. Tanaka, M. Nakao, and M. Gomyoda.

Atmospheric Environment ATENBP, Vol. 25A, No. 2, p 285-291, 1991. 4 fig, 4 tab, 24 ref.

Descriptors: \*Acid rain, \*Chemistry of precipita-tion, \*Japan, \*Precipitation, Ammonia, Calcium, Coasts, Deposition, Hydrogen ion concentration, Nitrates, Seasalt, Sulfates.

In order to understand the concentration and depo sition levels of the major ions in Shimane, on the Japan Sea coast where precipitation chemistry data Japan Sea coast where precipitation chemistry data are scarce, the precipitation was collected at three sites (Matsue, Cotsu and Masuda) from April 1985 to March 1988. The mean precipitation chemistry was very close to each other except for the seasalt concentration. Masuda showed a halved seasalt contribution compared with the other sites. The volume-weighted annual pH mean at each site ranged from 4.6 to 4.9. Nitrate to SO4(2-) equivalent ratios were in the range of 0.2 and 0.4 throughout the year. Ammonia and calcium species were interpreted to have neutralized approximately 70% of the original sulfuric and nitric acids. cies were interpreted to have neutralized approximately 70% of the original sulfuric and nitric acids. The annual depositions of the major ions in g/sq m/year were as follows: H(+), 0.023-0.037; NH4(+), 0.57-0.68; Ca(2+), 0.51-0.92; S04(2-), 3.29-5.04; NO3(-), 1.20-1.70. These levels were of Japan Environment Agency network results. (Author's abstract)

#### IMPACT OF CHANGING REGIONAL EMIS-SIONS ON PRECIPITATION CHEMISTRY IN THE EASTERN UNITED STATES.

New York Botanical Garden, Bronx, NY. Inst. of Ecosystem Studies. ary bibliographic entry see Field 5G.

# STATISTICAL ANALYSIS OF ERRORS IN ESTIMATING WET DEPOSITION USING FIVE SURFACE ESTIMATION ALGORITHMS. Pennsylvania State Univ., University Park. Envi-

ronmental Resources Research Inst. For primary bibliographic entry see Field 7B. W91-10474

#### RELATIONSHIP BETWEEN MEAN AND STANDARD DEVIATION IN PRECIPITATION CHEMISTRY MEASUREMENTS EASTERN NORTH AMERICA. ACROSS

Atmospheric Environment Service, Downsview (Ontario).

Atmospheric Environment ATENBP, Vol. 25A, No. 2, p 329-340, 1991. 6 fig, 7 tab, 25 ref.

Descriptors: \*Air pollution, \*Chemistry of precipitation, \*Path of pollutants, \*Precipitation, \*Statistical analysis, \*Statistical methods, Deposition, Ions, Standard deviation, Trend analysis

Characteristics of the distribution of concentration and deposition of major ions in precipitation strongly influence the way in which statistical analyses (for example, trend analysis) are done. It was established that a linear relationship exist between the mean and standard deviation of concentration and deposition of the major ions in precipi-tation for daily, weekly and monthly sampled data. The same relationship also existed for seasonal

#### Precipitation—Group 2B

precipitation-weighted-mean concentration and deposition of both sulfate and nitrate. The transformation, ln(X + sigma), where sigma is a constant that is zero for some ions and non-zero for others, eliminates the dependence of the standard devi-ation on the mean. It is recommended to assess first ation on the mean. It is recommended to assess first the robustness to heteroscedasticity of the statistical technique to be used. If a technique that does not assume homoscendasticity exists, it should be used. If the technique is only robust to small variations in the variance, one should estimate the variation of the variance in the data to be analyzed. If the estimated variation in the variance is too. If the estimated variation in the variance is too large, one should use the transformation ln(X + sigma). (Mertz-PTT) W91-10475

DRY DEPOSITION WASHOFF FROM FOREST TREE LEAVES BY EXPERIMENTAL ACID

Emory Univ., Atlanta, GA. Dept. of Biology. For primary bibliographic entry see Field 5B. W91-10476

INTERANNUAL VARIABILITY IN ACIDIC DEPOSITION ON THE MT. MITCHELL AREA

North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences. For primary bibliographic entry see Field 5B. W91-10478

ESCCP CLOUD DATA PRODUCTS. National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies. W. B. Rossow, and R. A. Schiffer. Bulletin of the American Meteorological Society BAMIAT, Vol. 72, No. 1, p 2-20, January 1991. 12 fig, 3 tab, 48 ref.

Descriptors: \*Climatology, \*Cloud cover, \*Data interpretation, \*Remote sensing, Albedo, Deserts, International Satellite Cloud Climatology Project, Model studies, Oceans, Seasonal variation, Statisti-cal analysis, Tropical regions, Weather.

The operational data collection phase of the International Satellite Cloud Climatology Project (ISCCP) began in July 1983. Since then, visible and infrared images from an international network of weather satellites have been routinely processed to produce a global cloud climatology. The cloud analysis procedure has three principal parts: cloud detection, radiative model analysis, and statistical analysis. The global annual mean cloud amount over three years is about 60%, the average optical thickness is about nine (equivalent to a spherical over three years is about 60%, the average optical albedo at 0.6 micrometers of about 50%), and the average cloud top temperature is 270 Kelvin. Older climatologies had suggested mean cloud amounts of about 50% and some newer satellite-based analyses obtained similar results. Lower values appear to be caused by incomplete global coverage, especially of southern oceans and less sensitive detection procedures. The classical climate zones are apparent in the variations of climate. mate zones are apparent in the variations of cloud amount. The mid-latitude ocean storm track and amount. The individual coveragence Zone are associated with large cloud amounts. Subtropical deserts are associated with cloud amounts below 40%. The marine stratus regimes are indicated by cloud amounts greater than 60% off the west coasts of continents. Average cloud top heights were about 3.5 km. Diurnal and seasonal variations were noted. Results showed that the average albedo of the clouds was about twice the average albedo of the clouds was about twice the average about of the surface, whereas the average temperature of the clouds was about midway between the average surface temperature and the effective radiating temperature of a clear, water-laden atmosphere. These relationships suggest that the effect of clouds on today's climate is a cooling effect. (Mertz-PTT) W91-10479

POTENTIAL IMPACTS OF CHANGE ON THE GREAT LAKES. Environmental Protection Agency, Washington, DC. Office of Policy, Planning and Evaluation. For primary bibliographic entry see Field 2H. W91-10480

RESEARCH ON CLOUDS AND PRECIPITA-TION: PAST, PRESENT AND FUTURE, PART

Washington Univ., Seattle. Dept. of Atmospheric Sciences.
For primary bibliographic entry see Field 3B.

COMPARISON OF MICROWAVE TECHNIQUES FOR MEASURING RAINFALL. Applied Research Corp., Landover, MD. A. R. Jameson.

Journal of Applied Meteorology JAMOAX, Vol. 30, No. 1, p 32-54, 1991. 24 fig, 4 tab, 7 ref, append. NASA grants NASS-30303 and NASS-30083.

Descriptors: \*Measuring instruments, \*Microwaves, \*Precipitation rate, \*Rainfall rate, \*Remote sensing, Measurement, Microwave rain estimator, Physical properties, Rainfall, Water measurement.

Many hydrological and other scientific problems require nearly instantaneous measurements of rainfall rate. A large number of techniques were evalufall rate. A large number of techniques were evaluated within a common framework for nearly instantaneous microwave measurements of rainfall and to determine the range of rainfall rates best suited to the various techniques and estimators. The physical basis of a technique as transformed by measurement imperfections of real instruments determines the ultimate performance capability of any microwave rain estimator. While many of the deficits of the measurement process apply to all techniques, the physics behind each estimator differs. A method is presented for objectively evaluating the physical bases of the techniques and for quantifying estimator performance for perfect instruments. These results, which represent the best possible performance expectations, are then temible performance expectations, are then tem pered by standard measurement errors to yield more realistic results. Analysis demonstrates that in general the minimization of rainfall estimate errors over a wide range of rainfall rates requires the simultaneous application of more than one microsimultaneous application of more than one micro-wave rainfall measurement technique. While this theoretical exercise provides useful guidance, measurement realities highlight the need for defini-tive experimental studies. (Author's abstract) W91-10499

PRECIPITATION CHANGES IN FALL, WINTER, AND SPRING CAUSED BY ST

LOUIS.
Illinois State Water Survey Div., Champaign.
S. A. Changnon, R. T. Shealy, and R. W. Scott.
Journal of Applied Meteorology JAMOAX, Vol.
30, No. 1, p 126-134, 1991. 4 fig, 4 tab, 17 ref.
NOAA Cooperative Agreement NA88RAH0810
and NA89RAH09086.

Descriptors: \*Missouri, \*Precipitation mapping, \*Rainfall, \*Rainfall rate, \*St Louis, \*Urban clima-tology, \*Urban hydrology, Plumes, Precipitation, Seasonal variation, Weather, Wind.

Analysis of precipitation events in the St. Louis area, based on pre-event low-level wind flow, was pursued to ascertain the presence of urban effects on fall, winter, and spring precipitation. Data from a circular, dense, raingage network were used to define quadrant (NW, NE, SE, SW) average precipitation. Winds before each event (443 events in 1971-1975) were used to define the urban plume and identify which quadrant was downwind of the city. Results for fall revealed a 17% increase in precipitation downwind of St. Louis and a 13% increase in events with their peak rainfall occurprécipitation downwind of St. Louis and a 13% increase in events with their peak rainfall occurring downwind; both outcomes were statistically significant at the 1% level. The downwind enhancement was greatest when pre-event winds were from the SE, and when average precipitation in the quadrant with the maximum value was either light (<5.1 mm) or quite heavy (>17.9 mm). The fall results agree well with earlier findings for summer rainfall that revealed a 25% increase due to enhancement in isolated airmass showers and during heavier, well-organized con-

vective systems. Winter precipitation indicated little precipitation change downwind of St. Louis. However, when SW pre-event winds existed (a flow often associated with convection), there was a flow often associated with convection), there was a statistically significant downwind increase in winter precipitation; but when pre-event winds were from SE or NW (flows frequently associated with stratiform precipitation), downwind decreases occurred. The number of spring precipitation conditions that maximized downwind of St. Louis was regulated to the converted by whence were stratificantly greater that expected by whence were significantly greater than expected by chance par-ticularly in light (<5.1 mm) events, but the total spring rainfall downwind increased only 4%. There was no suggestion of decreased precipitation in spring or fall. The urban influences to enhance precipitation appeared to be related to precipita-tion conditions with convective processes, and urban influences in more stratiform precipitation situations were negligible. (Author's abstract) W91\_10500

ESTIMATING THE EFFECTS ON THE RE-GIONAL PRECIPITATION CLIMATE IN A SEMIARID REGION CAUSED BY AN ARTIFI-CIAL LAKE USING A MESOSCALE MODEL. Uppsala Univ. (Sweden). Meteorologiska Institu-

L. Enger, and M. Tiernstrom. Journal of Applied Meteorology JAMOAX, Vol. 30, No. 2, p 227-250, February 1991. 20 fig. 4 tab,

Descriptors: \*Artificial lakes, \*Environmental effects, \*Lake-effect precipitation, \*Lakes, \*Meteorology, \*Model studies, \*Precipitation, \*Precipitation mapping, Local precipitation, Mesocale models, Precipitation forecasting, Semiarid climodels, Pre mates, Wind

The effects on the regional precipitation climate by the construction of an artificial lake in a semiarid region were studied. The study was performed using a mesoscale model to identify the larger-scale using a mesoscale moder to identify the arger-scale meteorological conditions when precipitation en-hancement was to be expected and to estimate the amount of precipitation enhancement in such situa-tions. The model results were combined with a tenyear synoptic observations dataset to estimate the mean annual increase in precipitation for the region. The results showed a significant increase in precipitation partly over the artificial lake itself, due to land/sea-breeze type circulations during periods when the large-scale wind is weak and the surface temperature of the sea is higher than that of the surrounding areas, and partly over the mountains north of the area in cases with sufficiently strong southerly winds causing the air to be lifted. Being aware of the uncertainty in the quantitative estimates, it was shown how a combination of mesoscale model sensitivity runs and climatological data can be used to estimate at least the order of magnitude change in precipitation and also identify the areas where it is likely to occur. (Author's abstract)

W91-10502

LABORATORY MEASUREMENTS OF SMALL RAINDROP DISTORTION, PART I: AXIS RATIOS AND FALL BEHAVIOR. Illinois State Water Survey Div., Champaign. Climate and Meteorology Section.
K. V. Beard, R. J. Kubesh, and H. T. Ochs.

A. V. Beard, R. J. Kubesh, and H. T. Ochs. Journal of the Atmospheric Sciences JAHSAK, Vol. 48, No. 5, p 698-710, March 1991. 7 fig, 4 tab, 27 ref. NSF grants ATM 84-19490, 86-01549, and 87-22688.

Descriptors: \*Rain, \*Rainfall, Equilibrium, Laboratory methods, Oscillation, Size, Variability.

The resonant interactions between eddy shedding and drop oscillations for millimeter diameter rain-drops were investigated in a series of laboratory measurements of axis ratio and fall behavior for water drops of diameter = 0.70-1.54 mm. Drops were produced at terminal velocity using a orifice-jet drop generator and allowed to fall several meters so that the initial oscillations (produced designs it benefits) deceased to a scalinglish smallduring jet breakup) decayed to a negligible ampli-tude before the drop shape was recorded using

#### **Group 2B—Precipitation**

stroboscopic photographs. The measured axis ratios had equilibrium values for the smallest sizes, ratios nad equinorium values for the smalest sizes, (diameter = 0.70-0.96 mm), but scattered some-what above equilibrium at intermediate sizes (di-ameter = 1.04-1.29 mm). An order of magnitude larger scatter in axis ratio, extending above and below equilibrium, was found for the largest sizes (1.40 mm) with the average axis ratio being oerow equinorium, was found for the largest sizes (> 1.40 mm) with the average axis ratio being larger than equilibrium. All but the smallest drops displayed a sideways drift varying from 1% of the terminal velocity for diameter = 0.82-11.04 mm, increasing sharply to 6% for diameter = 1.11 mm and gradually lowering to 2% at diameter = 1.54 and gradually lowering to 2% at diameter = 1.54
mm. The observed axis-ratio scatter and fall behavior were generally consistent with simple oscillation and drift responses to various size-dependent
wake configurations as determined from observations of freely falling bodies in liquid tank experiments. The small axis-ratio scatter above equilibrium and maximum in drift corresponds to the onset
of an asymmetric pulsating wake, whereas the
large axis-ratio scatter above and below equilibrium is an apparent axisymmetric oscillation. Sinceum is an apparent axisymmetric oscillation. Since the measured variance in axis ratio is largest for the largest size investigated, resonant oscillations extend far beyond the 1 mm size. Although such a broad coupling between eddy shedding and drop oscillations is not well understood, its existence would explain the shift in axis ratio found for small raindrop sizes using an aircraft optical-array probe and postulated from distrometer-differential reflectivity technique observations. (Author's abstract)
W91-10513

ELECTRICAL AND KINEMATIC STRUCTURE THE STRATIFORM PRECIPITATION GION TRAILING AN OKLAHOMA REGION TR SQUALL LINE.

National Severe Storms Lab., Norman, OK. T. J. Schuur, B. F. Smull, W. D. Rust, and T. C.

Journal of the Atmospheric Sciences JAHSAK, Vol. 48, No. 6, p 825-842, March 15, 1991. 18 fig, 1 tab, 50 ref. NOAA grant NA85RAH05046.

Descriptors: \*Electric fields, \*Meteorology, \*Oklahoma, \*Precipitation, \*Rainfall, \*Squalls, \*Storms, \*Thunderstorms, Clouds, Lightning, Radar, Stratiform clouds, Weather, Weather data

An electric field sounding through the transition zone precipitation minimum that trailed an Oklaho-ma squall line on June 18, 1987 provides informa-tion about the electrical structure within a midaltitude trailing stratiform cloud. A single-Doppler radar analysis concurrent with the flight depicts a kinematic structure dominated by two mesoscale flow regimes previously identified in squall-line systems: a strong midlevel, front-to-rear flow coin-ciding with the stratiform cloud layer and a de-scending rear inflow that sloped from 6.5 km AGL scelectric field magnitude vs height) at the strati-form cloud's trailing edge to 1.5 km AGL at the convective line. Electric field magnitudes as high as 113 kilovolts/m were observed by the electric as 113 kilovolts/m were observed by the electric field sounding, which reveals an electric field structure comparable in magnitude and complexity to structures reported for convective cells of thun-derstorms. The charge regions inferred with an approximation to Gauss' law have charge density magnitudes of 0.2-4.1 nanocoulombs/cubic m and vertical thicknesses of 130-1160 m; these values, too, are comparable to those reported for thunder-storm cells. In agreement with previous studies, an analysis of the lightning data revealed a bipolar cloud-to-ground lightning pattern with positive flashes being relatively more common in the stratiform region. From the analysis, it is concluded that the stratiform region electrical structure may have been advected from the squall line convective cells are the included that the stratiform of the squall line convective cells. as the in-cloud charge regions were primarily found within the front-to-rear flow. Screening layers were found at the lower and upper cloud layers were found at the fower and upper foodule boundaries. In situ microphysical charging also seems to be a possible source of charge in the stratiform region. It is hypothesized that the radar-derived similarities of this system to those previously documented suggests that the newly-docu-mented stratiform electrical structure might also be representative of this type of mesoscale convective system. (Author's abstract)

W91-10514

THREE-DIMENSIONAL SIMULATION OF AIRFLOW AND OROGRAPHIC RAIN OVER THE ISLAND OF HAWAII.

Scripps Institution of Oceanography, La Jolla, CA. K. Ueyoshi, and U. J. Han. Journal of the Meteorological Society of Japan JMSJAU, Vol. 69, No. 1, p 127-152, January 1991. 17 fig, 1 tab, 72 ref. USDA contract no. PSW-88-0006CA and NOAA grant NA86AA-D-CP104.

Descriptors: \*Computer models, \*Hawaii, \*Model studies, \*Orographic precipitation, \*Precipitation, \*Rainfall distribution, \*Simulated rainfall, Airflow, Mountains, Terrain analysis, Vortex.

A three-dimensional mesoscale numerical model was designed with the capability of simulating the airflow and orographically-induced rain in the presence of steep irregular terrain. The model utilizes a fourth-order accurate version of Arakawa's nzes a fourth-order accurate version of Arakawa's potential enstrophy and total energy conserving scheme to improve the simulation of nonlinear aspects of the airflow over steep topography, along with an adiabatic reference atmosphere to adough with an adabatic reference atmosphere to reduce the effects of orographic truncation errors. The precipitation processes are represented by large-scale condensation. The model is applied to the island of Hawaii. The results of a 24-hour simulation indicate the model is generally successful in reproducing leeward eddies depicted in the composite surface airflow patterns. A nondimensional analysis of vortex parameters suggests that sional analysis of vortex parameters suggests that the simulated vortex partern is an atmospheric analog of the Karman vortex street and compares favorably with an observed case of Hawaii vortices. Spatial distribution of simulated rainfall is also generally in good agreement with observations. However, the lack of precipitation in the lowland along the windward as well as leeward coast is apparent. The excess rainfall over the southern peninsula suggests the need for a fire grid mash to apparent. Ine excess raintail over the southern peninsula suggests the need for a finer grid mesh to improve representation of the effects of subgrid-scale mountain forcing. The model was applied to regional climate modeling through the use of large-scale objective analyses. (Author's abstract) W01.10312 W91-10517

ACID-BASE STATUS OF PENNSYLVANIA STREAMS: RESULTS FROM THE NATIONAL STREAM SURVEY.

Virginia Univ., Charlottesville. For primary bibliographic entry see Field 5B. W91-10726

ZONAL AVERAGE CLOUD CHARACTERIS-TICS FOR GLOBAL ATMOSPHERIC CHEMIS-TRY MODELLING.

Max-Planck-Inst. fuer Chemie, Mainz (Germany, F.R.). J. Lelieveld, P. J. Crutzen, and H. Rodhe

Available from the National Technical Information Service, Springfield, VA 22161, as N90-12992. Price codes: A04 in paper copy, A01 in microfiche. Report No. CM-76, June 1989. 54p, 10 tab, 60 ref.

Descriptors: \*Atmospheric chemistry, \*Climatology, \*Clouds, \*Distribution patterns, \*Model studies, Air circulation, Atmospheric circulation, Cloud cover, Convection, Mathematical studies.

A zonal average cloud distribution for the lower (approximately 6 km) troposphere was derived from surface observations of cloud occurrence and the average vertical extent of clouds. Assessments of updraft velocities through convective clouds and lifetime estimates of stratiform clouds were used to calculate the average time that air spends in clouds and the time between successive cloud encounters, as a function of latitude and altitude. The inferred cloud data compared well with satellite observations, but not very well with data de-rived from calculations with a general circulation rived from calculations with a general circulation model. For such models more effort has to be devoted to the development of cloud parameterizations in order to produce cloud distributions a needed for global atmospheric chemistry modelling. (Author's abstract)
W91-10728 CASE STUDIES IN DATA ANALYSIS. RDP. Inc., Waltham, MA.

A. J. Mazzella, D. E. Delorey, K. P. Larson, and P. Dickson.

P. Dickson. Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A215 342. Price codes: A03 in paper copy, A01 in microfiche. Report No. GL-TR-89-0172, June 30, 1989. 22p, 3 fig, 5 tab, 3 ref.

Descriptors: \*Data interpretation, \*Data processing, \*Meteorology, \*Rainfall, Climatic data, Computer programs, Computers, Rain gages.

Data processing and analysis have been performed for 42 individual rainfall measurement stations lo-cated throughout the United States. For most of these stations, the data were recorded for the tness stations, the data were recorded for the entire 10-yr period from January 1970 through December 1979, but data were recorded for a slightly different period for Urbana, and for shorter periods and selected months for San Sebastian (Puerto Rico), Kekaha (Hawaii), and Lalamilo (Hawaii). These data were initially recorded as weighing rain gage measurements, and were converted to one-minute rainfall rates according to previously described procedures. The data were then transferred by tape to the Geophysics Laboratory (GL) for further processing and analysis. The processing and display programs and procedures were initially developed for the GL CYBER system and peripherals, and were adapted and extended for use on one of the GL VAX/VMS systems. Because the tapes were originally created on a VAX/VMS system, this system migration enabled the elimination of the data unpacking process on the CYBER in favor of a simple file copy process on the VAX. Furthermore, the VAX copy process on the VAX. Furthermore, the VAX laser plotters could be used to generate the appropriate size and format plots more easily than the Calcomp drum plotter used by the CYBER. Summary rainfall data were merged with climatologimary rainfall data were merged with climatologi-cal data for each station, to provide a basis for model development of rainfall patterns. Critical rainfall rates for the attenuation of radio wave transmissions were also obtained from the Envi-ronmental Technical Applications Center (ETAC) and were utilized in conjunction with the rainfall rate data to evaluate transmission outage occur-rences for the individual station sites. These critical rates correspond to the climatological conditions appropriate to the individual sites for selected months, and are related to the transmission path lengths through the rainfall zone. (Lantz-PTD) lengths through the rainfall zone. (Lantz-PTT)

CORRELATED OCEANIC AND CONTINENTAL RECORDS DEMONSTRATE PAST CLIMATE AND HYDROLOGY OF NORTH AFRICA (0-140 KA).

Centre National de la Recherche Scientifique, Marseille (France). Lab. de Geologie du Quater-

A. M. Lezine, and J. Casanova. Geology GLGYBA, Vol. 19, No. 4, p 307-310, April 1991. 3 fig, 32 ref, append.

Descriptors: \*Africa, \*Cores, \*Paleoclimatology, Pealcohydrology, Stratigraphy, Calcium carbon-ate, Climatic changes, Dinoflagellates, Humid cli-mates, Oxygen isotopes, Pollen, Radioactive dating, Spores, Statistical analysis, Vegetation.

Environmental reconstruction of the latest climatic cycle in Africa has been severely limited by the incomplete record, owing primarily to major discontinuities in lacustrine sediments preserved in a predominantly arid climate. Analysis of pollen and dinocysts in a core from the eastern Atlantic (core V22-196; lat 13 degree 50 minutes north, long 18 degrees 57 minutes west) provides the first continuous record of paleoclimate and paleohydrology for the latest climatic cycle. During interglacial intervals, increases in pollen input from humid vegetation zones are correlative with high dinocyst productivity. The data indicates a close coinci-dence of northward extensions of Sudanian and Guinean vegetation zones in North Africa and increases in freshwater input into the Atlantic. Direct evidence indicates positive hydroclimatic phases at 135, 125, 103, 80, 47, and 12-10 ka,

#### Precipitation—Group 2B

coincident with widespread continental records of high lake levels, that confirm the validity of the U/ Th chronology. (Author's abstract)

HYDROLOGICAL ASPECTS OF THE 1988 DROUGHT IN ILLINOIS, Illinois State Water Survey Div., Champaign. Cli-matology and Meteorology Section. W. M. Wendland.

Water Resources Bulletia WARBAQ, Vol. 26, No. 6, p 913-920, December 1990. 5 fig, 2 tab.

Descriptors: \*Drought, \*Illinois, \*Precipitation, \*Rainfall-runoff relationships, \*Surface-ground-water relations, \*Water deficit, Annual precipitat-tion, Areal precipitation, Attitudes, Drought ef-fects, Hydrologic budget, Lakes, Precipitation in-tensity, Precipitation mapping, Recharge, Rivers,

Drought is a complex mix of the magnitude, dura-tion, and areal extent of a precipitation deficit. In simple terms, a drought exists when water demand simple terms, a drought exists when water demand exceeds supply for an extended period. Drought perception, on the other hand, is also a function of the sensitivity of an activity to water availability, the time of year, and perhaps, the magnitude of the deficit relative to some 'expected' value. Drought has been evaluated in terms of the magnitude and has been evaluated in terms of the magnitude and duration of the 1988 spring and summer precipita-tion shortfall in Illinois, and various components of the hydrologic budget, both surface and sub-sur-face (i.e., soil moisture, river flow, lakes and rivers, and groundwater). The response time of some of these components was investigated, relative to the time of precipitation. Lags were noted in the re-sponse of soil moisture, lakes, and groundwater to receipitation. These lags were not uniform, nor are sponse of soil moisture, lakes, and groundwater to precipitation. These lags were not uniform, nor are were they constant through time. These unconformities in the response to precipitation occurred because recharge to any of these components depended in part on their sensitivity to change, the antecedent conditions, and the magnitude and rate of the renewing precipitation. (Korn-PTT) W91-10810

POTENTIAL EFFECTS OF GLOBAL WARM-ING ON THE PRIMARY PRODUCTIVITY OF A SUBALPINE LAKE.
CH2M/Hill, Sacramento, CA.
For primary bibliographic entry see Field 2H.
W91-10819

ESTIMATION OF THE MEAN FIELD BIAS OF

ESTIMATION OF THE MEAN FIELD BIAS OF RADAR RAINFALL ESTIMATES. Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research. J. A. Smith, and W. F. Krajewski. Journal of Applied Meteorology JAMOAX, Vol. 30, No. 4, p 397-412, April 1991. 8 fig. 1 tab, 37 ref,

Descriptors: \*Meteorological data, \*Probable maximum precipitation, \*Radar, \*Rainfall, \*Rainstorms, \*Statistical models, \*Statistics, Data interpretation, Estimating equations, Parameter estimation.

Procedures were developed for estimating the mean field bias of radar rainfall estimates. Mean field bias is modeled as a random process that varies not only from storm to storm but also over varies not only from storm to storm but also over the course of a storm. State estimates of mean field bias are based on hourly raingage data and hourly accumulations of radar rainfall estimates. The pro-cedures were developed for the precipitation proc-essing systems used with products of the Next Generation Weather Radar (NEXRAD) system. Generation Weather Radar (NEARAD) system.

To implement the state estimation procedures, parameters of the bias model must be specified. Likelihood-based procedures were developed for estimating these parameters. A simulation experiment was carried out to assess performance of the parameter estimation procedure. Convergence of parameter estimators is enabled to the cases studied. rameter estimators is rapid for the cases studied, with data from approximately 25 storms, providing parameter estimates of acceptable accuracy. The state estimation procedures were applied to radar and raingage data from the 27 May 1987 storm,

which was centered near the NSSL radar on Norman, Oklahoma. The results highlight depend-ence of the state estimation problem on the param-eter estimation problem. (Author's abstract) W91-10857

USE OF SINGLE-DOPPLER RADAR FOR ESTIMATING MAXIMUM HAILSTONE SIZE.

National Severe Storms Lab., Norman, OK. A. Witt, and S. P. Nelson. Journal of Applied Meteorology JAMOAX, Vol. 30, No. 4, p 425-431, April 1991. 4 fig, 2 tab, 40 ref.

Descriptors: \*Hail, \*Precipitation, \*Radar, \*Rainstorms, \*Remote sensing, Data interpretation, Doppler radar, Estimating equations, Meteorologi-

The relationship between a storm's divergent outflow magnitude at upper levels and maximum hail-stone size was investigated by analyzing single-Doppler radar data for 49 severe hailstorms. Two Doppier radar data for 49 severe natisforms. I wo different techniques were developed for use with single-Doppier radar data to estimate the magnitude of divergent outflows. The developed techniques show considerable skill at estimating the maximum hailstone size produced by a thunderstorm, with the correlation coefficients between the parameters used and maximum hailstone size being as high as 0.89. The data also show that estimates of maximum hailstone size have an 80% chance of being accurate to within + or -1.4 cm.

The developed techniques are computationally simple and should be useful for real-time estimation of the maximum hailstone size likely to be produced by a thunderstorm. (Author's abstract) W91-10858

MICROCLIMATOLOGICAL MICROCLIMATOLOGICAL INVESTIGATIONS IN THE TROPICAL ALPINE SCRUB OF MAUI, HAWAII: EVIDENCE FOR A DROUGHT-INDUCED ALPINE TIMBERLINE. Goettingen Univ. (Germany, F.R.). Systematisch-Gebotanisches Inst. und Neuer Botanischer

For primary bibliographic entry see Field 2I. W91-10878

RAINFALL INTERCEPTION AND BOUNDARY LAYER CONDUCTANCE IN RELATION TO TREE SPACING.

Edinburgh Univ. (Scotland). Dept. of Forestry and Natural Resources.

For primary bibliographic entry see Field 2I. W91-10905

CANADIAN ATLANTIC STORMS PROGRAM: PROGRESS AND PLANS OF THE METEORO-LOGICAL COMPONENT.

Atmospheric Environment Service, Downsview (Ontario).

R. E. Stewart.
Bulletin of the American Meteorological Society
BAMIAT, Vol. 72, No. 3, p 364-371, March 1991.
4 fig. 61 ref.

Descriptors: \*Atlantic Ocean, \*Canada, \*Meteorological data, \*Meteorology, \*Precipitation, logical data, \*Meteorology, \*Precipitation, \*Storms, Coasts, Meteorological models, Simulation analysis, Weather patterns.

The Canadian Atlantic Storms Program (CASP) field project was conducted from 15 January to 15 March 1986 over Atlantic Canada in conjunction with the American Genesis of Atlantic Lows Experiment (GALE). The goals of CASP were to begin the process of understanding and eventually better predicting the mesoscale structure of East Coast storms as well as the storms themselves. Coast storms as well as the storms themselves. Conceptual models of the storms have been formulated, the nature of cyclogenesis and the structure of frontal surfaces have been investigated, and precipitation regions and precipitation type transitions have been studied. The storms exhibit an organization similar to that seen elsewhere, although the occurrence of a variety of precipitation types has not been studied extensively before. The geographical setting of the warm Gulf Stream to the south and the cold, often snow-covered, land

represents a unique situation which can sometime assist in rapid storm evolution and it can also result in the establishment of heavy precipitation produ ing regions along coastlines. Numerical weather simulations have been used to better understand simulations have been used to determine understand critical parameters affecting storm behavior and improvements in instrumentation have been made. CASP II will be able to utilize improved observational capabilities. To properly monitor the three-dimensional kinematic and thermodynamic fields over the ocean and ice fields, a dropsonde capabilities. ity utilizing a cross-chain Loran system will be used. Future research activities are needed to better understand the interaction of the storms with surface features such as coastlines and sea ice. (Fish-PTT) W91-10943

SOME UPDATED STATISTICAL ASSESSMENTS OF THE SURFACE TEMPERATURE RESPONSE TO INCREASED GREENHOUSE GASES.

Frankfurt Univ. (Germany, F.R.). Inst. fuer Meteorologie und Geophysik

C. D. Schonwiese, and K. Runge.

International Journal of Climatology IJCLEU, Vol. 11, No. 3, p 237-250, April 1991. 9 fig. 3 tab, 37 ref. German (FRG) Climate Research Pro-gramme (BMFT, project number KF 2012 9).

Descriptors: \*Air temperature, \*Carbon dioxide, \*Climatic changes, \*Climatology, \*Global warming, \*Greenhouse effect, \*Model studies, Atmospheric circulation, Climatic data, El Nino/Southern Oscillation, Meteorological models, Regression analysis. Statistical analysis

An earlier study has analyzed the surface temperature response to increasing atmospheric carbon dioxide (CO2) concentrations based on long-term observational climate time series using multiple regression statistical techniques. These assessments were compared with the results from general circulation model experiments. Recently, improved climate data sets were used, adding ENSO (El climate data sets were used, adding Ensol (E) Mino/Southern Oscillation) forcing to the multiple regression models, the volcanic forcing parameters were improved, and phase shifts of the temperature response to the forcing parameter time series were introduced. In addition, not only CO2 but also 'equivalent' CO2 concentrations were used to accept count for additional greenhouse gases. The signal assessments were based on three different temperature data sets, all forcing parameter time series used, different periods (from 1851-1980), and different filters (3 and 10-year low-pass). The results show that, for the mean Northern Hemisphere surface air temperature, the CO2 doubling extraposurface air temperature, the CO2 doubling extrapo-lation leads to signals (temperature increase) of the order of 2.4-5.4 K, in the 'equivalent' case 2.3-6.1 K. The corresponding mean Southern Hemisphere results are 2.5-4.6 K (CO2 doubling) and 2.9-5.4 K ('equivalent'). The mean global data extrapolations lead to 2.7-4.4 K (CO2 doubling) and 2.9-5.2 K ('equivalent'). The order of magnitude of the statistically assessed CO2 doubling signals (2.7-4.4 K) tically assessed CO2 doubling signals (2.7-4.4 K) agrees very well with climate model intercomparisons made previously. Following this result, the 'industrial' greenhouse-gas-induced surface air temperature signals may also be specified: on a global average, this temperature rise may be of the order of 0.5-0.9 K ('equivalent') with 0.3-0.6 K due to CO2 forcing ('reduced to CO2'). It was concluded that one may derive a possible date of the greenhouse gas signal detection in the observational surface air temperature data based on these latest statistical results. (Fish-PTT) statistical results. (Fish-PTT) W91-10969

CLIMATIC CHANGE AND FUTURE AGRO-CLIMATIC POTENTIAL IN EUROPE.

Birmingham Univ. (England). Dept. of Geogra-

pny.

T. R. Carter, M. L. Parry, and J. H. Porter.
International Journal of Climatology IJCLEU,
Vol. 11, No. 3, p 251-269, April 1991. 7 fig, 1 tab,
54 ref. The Commission of the European Communities Contract No. EY 4C.0017 UK.

#### Group 2B-Precipitation

Descriptors: \*Agriculture, \*Climatic changes, \*Climatology, \*Europe, \*Global warming, \*Greenhouse effect, Air temperature, Carbon dioxide, Computerized maps, Corn, Denmark, England, Finland, Germany, Poland, Russia, Scandinavia, Weather natterns Weather patterns

A study has been performed to evaluate the broad-scale sensitivity of agriculture to climatic change in scale sensitivity of agriculture to climatic change in Europe, using an agroclimatic index, effective tem-perature sum (ETS), to relate temperature patterns to the cultivable limits of grain maize (Zea mays). A computer mapping system for the European region was adopted to map ETS on the basis of both present-day and possible future mean tem-peratures. In this way, changes in climate can be depicted as geographical shifts of the limit of po-tential grain maize cultivation. The results indicate that a mean annual temperature increase of only 1 tentia grain maiaze cultivation. The results indicate that a mean annual temperature increase of only 1 C (within the present-day range of interannual variability) would open up large areas in southern England, the Low Countries, eastern Denmark, northern Germany, and northern Poland to potential tenties authority and northern Poland to potential tenties authority and interest of 4 Countries. northern Germany, and northern Poland to potential maize cultivation. An increase of 4 C would move the limit into central Fennoscandia and northern Russia. These represent rates of northward shift of approximately 200-350 km/C in western Europe and 250-400 km/C in eastern Europe. Comparison of these shifts with those estimated on the basis of general circulation model (GCM) projections of future temperatures suggests that a 1 C warming will be achieved well before the time the global climate responds fully to an equivalent doubling of atmospheric carbon dioxide, possibly as early as 2010. Shifts comparable with those for a 4 C warming are achieved under all the GCM scenarios of doubled CO2, occurring perhaps as soon narios of doubled CO2, occurring perhaps as soon as 2050. The rate of shift of the grain maize limit implied for this (high) emissions scenario is in the order of 150-200 km per decade over the next 70 years, slower than this during the next few decades, but faster thereafter. Such shifts would offer new opportunities for farmers in different regions of northern Europe. However, immediate attention should be directed towards more detailed assessments of crop potential in regions identified as currently marginal for grain maize. (Author's ab-W91-10970

VARIATION OF MOISTURE CONDITIONS IN CHINA DURING THE LAST 2000 YEARS. State Univ. of New York at Stony Brook. Inst. for Terrestrial and Planetary Atmospheres. For primary bibliographic entry see Field 2A. W91-10971

TREE-RING RECONSTRUCTED SUNSHINE DURATION OVER CENTRAL USA. Arkansas Univ., Fayetteville. For primary bibliographic entry see Field 21. W91-10972

PRECIPITATION IN BRITAIN: AN ANALYSIS OF AREA-AVERAGE DATA UPDATED TO 1989.

University of East Anglia, Norwich (England). Climatic Research Unit.

J. M. Gregory, P. D. Jones, and T. M. L. Wigley. International Journal of Climatology IJCLEU, Vol. 11, No. 3, p 331-345, April 1991. 6 fig. 10 tab, 7 ref. Water Research Centre, Medmenham, con-tract number 4708.

Descriptors: \*England, \*Ireland, \*Meteorological data, \*Precipitation, \*Scotland, \*Wales, Areal precipitation, Climatic data, Correlation analysis, Rainfall, Spatial distribution, Temporal distribution tion, Time series analysis.

An extension and update has been made of a previ-An extension and update has been made of a previ-ous analysis of spatial and temporal variations in precipitation over England and Wales. In the newest study, the U.K. was divided into nine re-gions of coherent precipitation variability on the basis of our earlier principal components analysis. Daily and monthly time-series were assembled for seven sites within each region, and area-average series and statistics were computed. Correlations were investigated among the sites within each

region, among regions on daily to annual time-scales. Monthly time-series spanning the period 1931-1989 for England and Wales, for Scotland and for Northern Ireland were calculated by fur-ther combining the nine regions. Examination of the intersite variability within the regions confirms that daily rainfall series from individual sites are highly correlated, and therefore that these regions of coherent precipitation variability on daily and longer time scales. Area-average series correlations longer time scales. Area-average series correlations between the seasonal and annual time-series for different regions are strongest for regions that are close together. In particular, the western side of the country correlates more strongly with the west, and likewise for the eastern regions. However, there are only very weak relationships between the regions of England and Wales and those of Scotland. From the regional series constructed, no long-term trends in precipitation were apparent. (Fish-PTT) W91-10973

RELATION OF ATMOSPHERIC CO2 TO TROPICAL SEA AND AIR TEMPERATURES AND PRECIPITATION. National Oceanic and Atmospheric Administra-tion, Silver Spring, MD. Air Resources Lab. W. P. Elliott, J. K. Angell, and K. W. Thoning. Tellus TELLAL, Vol. 43B, No. 2, p 144-155, April 1991. 5 fig, 5 tab, 21 ref.

Descriptors: \*Air temperature, \*Atmospheric circulation, \*Carbon dioxide, \*Climatic changes, \*Climatology, \*El Nino/Southern Oscillation, \*Marine climates, Alaska, American Samoa, Correlation analysis, Hawaii, Pacific Ocean, Precipitation, South Bola, Teorica poses tion, South Pole, Tropic zone.

Associations between the season-to-season changes in CO2 concentration and the sea-surface tempera-ture in the eastern equatorial Pacific, the tropospheric air temperature, and the precipitation in the tropics have been explored. The CO2 records the tropics have been explored. The CO2 records at Mauna Loa, Hawaii, and the South Pole from the Scripps Institution of Oceanography and the GMCC/NOAA (Geophysical Monitoring for Climate Change/National Oceanic and Atmospheric Administration) program, as well as the GMCC records at Barrow, Alaska, and American Samoa, were used after the annual cycle and the growth due to fossil fuel emission was removed. It was found that the correlation between CO2 aboves. found that the correlation between CO2 changes and each of the other variables changes with time. In particular, the period from about 1968 to about 1978 was the period of highest correlation, which was also the period when the climate variables were best correlated with each other. The air were best correlated with each other. The air temperature and the precipitation were also correlated with CO2 changes as was SST (sea-surface temperature). Also, there are individual seasons when the CO2 changes are much better correlated with the climate variables than at other seasons. Furthermore, El Nino events, while the source of the largest signal in the CO2 record, are by no means the same from one event to the next. These results were interpreted as further confirmation that the apparent effect of SST on the CO2 record comes less from changes in the equatorial eastern comes less from changes in the equatorial eastern Pacific Ocean than from climate changes through-out the globe. Climate effects on the terrestrial biosphere seem a likely source of much of the interannual variation in atmospheric CO2. (Author's abstract)

WATER SUPPLY IMPLICATION OF CLI-MATE CHANGE IN WESTERN NORTH AMERICAN BASINS. Agricultural Research Service, Beltsville, MD.

Agricultural Research Service, Densylvas, Mar-Hydrology Lab.

A. Rango, and V. Van Katwijk.

IN: International and Transboundary Water Re-sources Issues. American Water Resources Asso-ciation, Bethesda, Maryland, 1990. p 577-586, 7 fig.

Descriptors: \*Climatic changes, \*Climatology, \*Global warming, \*Hydrologic budget, \*North America, \*Water supply, Air temperature, Model studies, Rio Grande Basin, Runoff, Seasonal variation, Snowmelt, Water demand, Water resources

A snowmelt-runoff model and a series of stepwise changes in model variables and parameters have been employed to determine possible hydrologic responses to climate change on western North American basins. The expected increase in mean global air temperature will have a major effect by causing a redistribution of flow with pronounced increases in April and May and decreases in the Summer months. The increase in temperature will also cause a time shift of certain model parameters. Summer months. The increase in temperature will also cause a time shift of certain model parameters which will somewhat reduce the April and May increases in flow and magnify the decreases in the Summer months. It is not well known what kind of changes in precipitation will result from climate change. This study shows, however, that a change in the April 1 snow water equivalent can potentially cause a significant hydrologic response, especially in concert with the temperature increase. For example, on the Rio Grande basin a 3 C increase in temperature in combination with a 25% decrease in April 1 snow water equivalent and a decrease in April 1 snow water equivaent and a 10% decrease in snowmelt season precipitation will cause a 30% decrease in seasonal flow, as well as a 53% increase in April runoff and a 61% decrease in June runoff. Such a response, if widespread, could cause a serious widening of the already existing gap between water supply and water demand in western North America. (See also W91-11003) (Author's abstract)

SIMULATED HYDROLOGIC EFFECTS OF CLIMATIC CHANGE IN THE DELAWARE RIVER BASIN.

Geological Survey, West Trenton, NJ. For primary bibliographic entry see Field 5C. W91-11060

GREAT LAKES HYDROLOGICAL IMPACTS OF 2XCO2 CLIMATE CHANGE,

National Oceanic and Atmospheric Administra-tion, Ann Arbor, MI. Great Lakes Environmental Research Lab.

For primary bibliographic entry see Field 5C. W91-11061

CHALLENGE OF SUSTAINING PRODUCTIVI-TY IN THE FACE OF CO2-INDUCED CHANGE.

Environmental Protection Agency, Washington, DC. Office of Policy Analysis. For primary bibliographic entry see Field 5C. W91-11073

CHEMICAL COMPOSITION OF INDIVIDUAL STORMS AS A FUNCTION OF AIR PARCEL TRAJECTORIES FOR THE PREDICTION OF ACID RAIN CHARACTERISTICS.

British Columbia Ministry of Environment, Victoria. Waste Management Branch.
For primary bibliographic entry see Field 5B.
W91-11075

EFFECTS OF ACID RAIN ON EPIPHYTIC ORCHID GROWTH.

Barry Univ., Miami Shores, FL. Div. of Biological and Biomedical Sciences. For primary bibliographic entry see Field 5C. W91-11076

CLOUD/CRYOSPHERE INTERACTIONS. Lamont-Doherty Geological Observatory, Palisades, NY.

sades, NY.

G. Kukla, and D. A. Robinson.

Available from the National Technical Information

Service, Springfield, VA. 22161, as AD-A208 377.

Price codes: A03 in paper copy, A01 in microfiche.

Completed Project Summary Number AFOGRTR-89-0590, April 19, 1989. 40p. 22 fig. 2 tab, 24

ref. US Air Force Grant AFOSR 86-0053.

Descriptors: \*Cloud cover, \*Cloud physics, \*Cryosphere, \*Ice, \*Meteorology, \*Snow, Arctic zone, Model studies, SNODEP Model, Seasonal variation, Snowmelt.

#### Precipitation—Group 2B

Cryospheric dynamics, particularly relationships and feedback between clouds and the cryosphere when snow cover is forming or dissipating were analyzed, and algorithms and climatologies used in Air Force operational snow and cloud cover prod-ucts were assessed. These objectives have been met, resulting in improvements in snow and cloud met, resutting in improvements in snow and cloud climatologies as well as leading to an increased understanding of: (1) seasonal and inter-annual variations in snow and cloud cover; (2) dynamics of the onset of melt season in arctic regions; (3) performance of Air Force nephanalyses in marginal cryosphere regions; and (4) performance of the Air Force SNODEP model. Project results instability to the project results in-Air Force SNODER model. Project results in-clude: (1) cloud cover in the Arctic Basin has a late May-early June maximum in extent and thickness, followed by a period of less extensive and thinner cover extending into early August. Cloud condi-tions are associated with the distribution of surface ressure and the flow of air into the Basin at the arface and aloft; (2) over arctic lands and sea ice, surface and aloft; (2) over arctic lands and sea ice, the timing and duration of the snow melt season, which strongly influences the surface mobility of personnel and machinery, vary geographically within a year and across the region from year to year; (3) increased spring cloudiness and the onset of the melt season over sea ice coincide, suggesting that both are related to the northward transport of moist air into the Basin by synoptic disturbances, rather than one solely driving the other. Results over arctic lands are less conclusive. Varying conditions of thee snow pack, the surface albedo, the seasonal and latitudinal distributions of solar insolation reaching the top of the atmosphere, are among seasonal and latitudinal distributions of solar insolation reaching the top of the atmosphere, are among the other factors influencing melt; (4) a southward shift in the mid-winter snow line was found over the central United States in the past 50 years; and (5) short-term variability of snow extent was ob-served over the Tibetan Plateau. Despite the cold winter temperatures in this region, the presence of snow cover is strongly precipitation dependent, perhaps more so than in any other part of the world. (Lantz-PTT) W91-11095

MULTIPARAMETER RADAR ESTIMATION OF RAINDROP SIZE DISTRIBUTION. Colorado State Univ., Fort Collins.
For primary bibliographic entry see Field 7B.
W91-11097

RAINWATER AND THROUGHFALL CHEMISTRY IN A TERRE FIRME' RAIN FOREST: CENTRAL AMAZONIA.
Instituto de Pesquisas Espaciais, Sao Paulo (Brazil). Lab. de Pesquisas Atmosfericas e Oceanicas

Our M. C. Forti, and L. M. Moreira-Nordemann. Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 96, No. 4, p 7415-7421, April 20, 1991. 2 fig, 6 tab, 34 ref.

Descriptors: \*Acid rain, \*Amazon River Basin, \*Brazil, \*Chemistry of precipitation, \*Rain forests, \*Water chemistry, Amazon Boundary Layer, Ammonium, Calcium, Chlorides, Ducke Reserve, Forest watersheds, Global Tropospheric Experiment, Hydrogen ion concentration, Ions, Magnesium, Path of pollutants, Potassium, Seasonal distribution, Sodium, Sulfates. Throughfall. bution, Sodium, Sulfates, Throughfall.

The Global Tropospheric Experiment (GTE)-Amazon Boundary Layer (ABLE) study was con-ducted during the wet (April-May) and dry (August-September) seasons of 1987. For each period a continuous record of rainwater and throughfall composition and amount was obtained in a 'terra firme' (nonflooded) rainforest ecosystem in Central Amazonia (Brazil). During the GTE-ABLE 2B campaign, samples were obtained at the Ducke Reserve (2 deg 57 min S, 59 deg 58 min W). All samples were collected from April 1 to May 13 and from August 1 to October 1, and analyzed for Na(+), K(+), Mg(2+), Ca(2+), NH4(+), Cl(-), and SO4(2-), and pH. The rainwater was acidic, with a volume-weighted mean pH of 4.6 for the with a volume-weighted mean pri of 4.5 for the two periods. Rainwater input from the dry period was two times greater for Na(+), Mg(2+), NH4(+), and SO4(2-) and about four times greater for K(+) than rainwater input from the dry wet period. The ionic concentrations in throughfall were higher than those in rainwater, except for NH4(+) during the dry period. This enrichment of throughfall is attributed to the interaction of precipitation with the forest canopy. (Author's ab-W91-11218

CLASSIFICATION OF SNOW COVER AND PRECIPITATION USING THE SPECIAL SENSOR MICROWAVE IMAGER. National Oceanic and Atmospheric Administration, Washington, DC. Environmental Data and Information Service. For primary bibliographic entry see Field 7B. W91-11219

VARIATION OF THE STABLE ISOTOPES OF WATER WITH ALTITUDE IN THE SAINT ELIAS MOUNTAINS OF CANADA. National Hydrology Research Inst., Saskatoon

(Saskatchewan).
For primary bibliographic entry see Field 2C.
W91-11220

SIMULATION OF PRECIPITATION BY WEATHER TYPE ANALYSIS. Geological Survey, Denver, CO. Water Resources

L. E. Hay, G. J. McCabe, D. M. Wołock, and M. A. Ayers.

Water Resources Research WRERAQ, Vol. 27, No. 4, p 493-501, April 1991. 13 fig, 15 ref.

Descriptors: \*Climatology, \*Data interpretation, \*Delaware River Basin, \*Meteorology, \*Model studies, \*Precipitation, \*Simulation, \*Time series analysis, Climate models, Climates, Mathematical models, New York, Pennsylvania, Temporal varia-

The quantitative description of temporal variability in precipitation is critical to an understanding of hydrologic processes. A variety of precipitation simulation methods have been reported. A method of precipitation simulation that incorporates climatological information has been developed. A Markovian-based model was employed to generate temporal sequences of six daily weather types: high pressure, coastal return, maritime tropical return, frontal maritime tropical return, cold frontal overrunning, and warm frontal overrunning, and warm frontal overrunning, and warm frontal overrunning observed statistical relations between weather types and precipitation characteristics. When this method was applied to an area in the Delaware River basin (Pennsylvania/New York), the statistics describing average precipitation, extreme pretics describing average precipitation, extreme pre-cipitation, and drought conditions for simulated precipitation closely matched those of the ob-served data. Potential applications of this weather type precipitation model include climatic change research and modeling of temperature and evapo-transpiration. (Author's abstract)
W91-11230

EFFICIENCY WITH WHICH DRIZZLE AND PRECIPITATION SIZED DROPS COLLIDE WITH AEROSOL PARTICLES. University Coll., Galway (Ireland). Dept. of Ex-

University Coll., Gaiway (Ireland), Beptimental Physics.
B. T. McGann, and S. G. Jennings.
Atmospheric Environment ATENBP, Vol. 25A, No. 3/4, p 791-799, 1991. 5 fig, 3 tab, 14 ref.

Descriptors: \*Aerosols, \*Cloud physics, \*Mathematical models, \*Particle size, \*Precipitation, \*Precipitation scavenging, Clouds, Electrical properties, Particulate matter, Rainfall rate, Relative hu-

Values of collision efficiency and scavenging rates for drops interacting with aerosol particles were presented using more accurate flow fields than presented using more accurate flow heats that previous work and for a much greater number of drops than hitherto obtained. All calculations were performed at an ambient temperature of 10 C and atmospheric pressure of 900 mb. Collision efficience. was computed for a drop radius range from 50 500 micrometers, for particle radius from 0.005

to 10 microns, for relative humidity values of 50, 75, 95, and 100%, and for particle density of 1,000, 1,500, 2,000, and 2,500 kg/cu m. In addition the collision efficiency was also calculated for electric charges on the drop and particle, and for an elec-tric field, representative of typical thundercloud values. A rigorous trajectory model was used to-gether with a flux model and comparison is made between them in the overlap size region. Precipita-tion scavenging rates and the percentage of aerosol particles scavenged by precipitation drops de-scribed by Marshall-Palmer size distributions was calculated. Predictions for the two models generalcalculated. Predictions for the two models general-ly agreed to within a factor of two for particle radius <0.8 microns. Collision efficiency values using the trajectory model increased with decreas-ing relative humidity with the increase greatest for the smallest sized drops and particles. The collision efficiency is increased due to electrical forces, since the electrical forces are attractive causing the particle to cross air flow streamlines towards the drop. The effect was greater for smaller drops and particles. Collision efficiency increased with partiparticles. Collision efficiency increased with parti-cle density for the relatively larger particles due to increased particle inertia with an increased likeli-hood of penetrating the air flow streamlines. The percent of scavenged particles is less than 1% under all conditions tested for particle radius <1 micron and is generally of the order of 0.1% or less for the submicrometer aerosol particle frac-tion. There is between about 25 and 30% increase in percentage of particles scaveneed for doubling in percentage of particles scavenged for doubling of the precipitation rate throughout the particle size range due to a similar order mean increase in drop concentration (Geiger-PTT) with precipitation W91-11252

AEROSOL AND HYDROMETEOR CONCENTRATIONS AND THEIR CHEMICAL COMPOSITION DURING WINTER PRECIPITATION ALONG A MOUNTAIN SLOPE; III. SIZE-DIF-FERENTIATED IN-CLOUD SCAVENGING EF-

Eidgenoessische Technische Hochschule, Zurich (Switzerland). Atmospheric Physics Lab. T. Schumann

Atmospheric Environment ATENBP, Vol. 25A, No. 3/4, p 809-824, 1991. 11 fig, 5 tab, 28 ref.

Descriptors: \*Aerosols, \*Chemistry of precipita-tion, \*Cloud chemistry, \*Nucleation, \*Particulate matter, \*Precipitation scavenging, Ammonia, Cloud physics, Condensation, Deposition, Nitrates,

During three winter seasons a mountain top station at 1620 m above sea level in central Switzerland instrumented with an electrical aerosol analyzer, an optical particle counter, a cascade impactor, meteorological sensors, and snow collectors was operated with high temporal resolution. With the obtained detailed data set size-dependent in-cloud scavenging efficiencies were determined. In-cloud scavenging could be explained as a combination of scavenging could be explained as a commission or nucleation scavenging (for particles with a diameter of 0.2-2 microns) and collection scavenging (by diffusive processes for particles smaller than 0.2 microns, and by impaction processes for those larger than 2 microns). The case-to-case variability of determined efficiencies was very large, being the smaller of simultaneous precipithe result of the influence of simultaneous precipi tation, the solubility of the aerosols, the m concentration of fine particles, and the maximum supersaturation reached during cloud formation. The experimentally determined efficiencies agree, The experimentary determined efficiencies agree, at least qualitatively, with current nucleation theories. Field experiments reported by other authors reconfirm the mean total efficiency of 70% (by aerosol volume) found in this study. The inorganic ion concentrations found in aerosols and precipitation indicate that the precipitation first falling continued outpropositional amounts, of corrections of corrections of the property of corrections of the property tion indicate that the precipitation first falling contained overproportional amounts of coarse, Ca(++)-enriched aerosol particles, advocating that the transformation of cloud water to precipitation water favors droplets with pronounced cloud condensation nuclei characteristics. The submicron particles, consisting mainly of NO3(-), SO4(--), and NH4(+-), are readily incorporated into cloud water, but much less efficiently transformed into

#### **Group 2B—Precipitation**

precipitation than super-micron particles. (Author's abstract) W91-11253

RAINFALL INTERCEPTION BY TREES OF PINUS RADIATA AND EUCALYPTUS VIMIN-ALIS IN A 1300 MM RAINFALL AREA OF SOUTHEASTERN NEW SOUTH WALES: II. INFLUENCE OF WIND-BORNE PRECIPITA-

Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Forest Research.

For primary bibliographic entry see Field 2D. W91-11346

EMPIRICAL METHOD OF ESTIMATING RAINGAGE AND RADAR RAINFALL MEAS-UREMENT BIAS AND RESOLUTION.

National Oceanic and Atmospheric Administra-tion, Washington, DC. Climate Analysis Center.

Tion, Washington, DC. Climate Analysis Center.

A. G. Barnston.

Journal of Applied Meteorology JAMOAX, Vol.
30, No. 3, p 282-296, March 1991. 4 fig, 2 tab, 20

Descriptors: \*Correlation analysis, \*Data interpre-tation, \*Mathematical models, \*Measuring instru-ments, \*Radar, \*Rain gages, \*Rainfall, Analysis of variance, Data acquisition, Literature review, Rainfall intensity, Remote sensing.

New methods for estimating the bias and resolution of radar and rain gage area were developed which average rainfall measurements over a defined area when both devices are employed simul-taneously. The bias of rain gage measurements for various rainfall amount ranges was estimated from published data, and the bias for radar measurement puoisned data, and the data for radar measurement was then determined through comparison with the rain gage recordings. Resolution estimations were carried out using error variance analysis on corresponding sets of gage and radar observations. The assumptions underlying this technique demand a uniform terrain for rainfall measurements, a large sample of cases, and, for one of the analysis options, a high correlation between radar and gage tions, a nign correlation between radar and gage rainfall measurements. The procedure was illustrat-ed using the gage and rainfall data from the second phase of the Florida Area Cumulus Experiment (FACE-2). The gage sampling error variance esti-mations for various rainfall amount categories using an empirical radar-derived method were examined and compared with those of published studies using alternate methods and were found to studies using atternate methods and were found to be in general agreement. The FACE-2 gage net-work provided more highly resolved rainfall meas-urements than the WSR-57 radar in moderate or heavy rainfall, but the radar exhibited superior resolution in light rainfall if the radar rainfall ad-justment used in FACE was not carried out. The radar rainfall adjustment seemed to reduce radar measurement bias quite effectively, but the resolution was generally not improved and was degraded in below-median rainfall amounts. (Author's abstract) W91-11409

EFFECT OF DECOUPLED LOW-LEVEL FLOW ON WINTER OROGRAPHIC CLOUDS AND PRECIPITATION IN THE YAMPA RIVER

VALLEY.
Colorado State Univ., Fort Collins. Dept. of At-

mospheric Science.
T. C. Peterson, L. O. Grant, W. R. Cotton, and D.

C. Rogers.

Journal of Applied Meteorology JAMOAX, Vol. 30, No. 3, p 368-386, March 1991. 15 fig, 3 tab, 13 ref. NSF Grants ATM-8109590, ATM-8704776, and ATM-8813345; the Army Research Office Contract DAALO3-86-k-0175; and the Colorado Aminthmed. Exercises Series Research Office Agricultural Experiment Station Projects Colo. 113 and 692.

Descriptors: \*Cloud physics, \*Flow pattern, \*Meteorology, \*Orographic precipitation, \*Yampa River Valley, Air masses, Atmospheric circulation, Climatic data, Colorado, Data interpretation, Meteorological data, Model studies, Precipitation, Simulation analysis.

Mountains often act as barriers to low-level flow creating regions of stagnant, decoupled flow within thermally stratified air masses. This study analyzes how a region of low-level decoupled flow affect the overlying orgraphic cloud. Three different methodologies were used to examine this problem. The first method involved analysis of one and a half months of precipitation and wind data from a 24-station mesonetwork located in the Yampa a 2-station incontension to the rampa River valley and surrounding mountains of north-west Colorado during the winter of 1981/1982 as part of the third Colorado Orographic Seeding Experiment. The second method was a case study analysis of two orographic storms using data from an instrumented cloud physics aircraft to supple-ment the data from the mesonetwork. The third method involved two dimensional numerical simu-lations using Colorado State Univaersity's Region-al Atmospheric Modeling System. The results show that the presence of extensive low-level decoupled flow causes part of the orographic lift of the mountain barrier to be experienced upstream of the barrier. This changes the location of conden-sate production which in turn shifts precipitation upstream and appears to enhance the precipitation efficiency for the entire barrier. (Author's abstract)

PERSISTENT PATTERNS OF THUNDERSTORM ACTIVITY IN THE CENTRAL UNITED STATES,

Indiana Univ. at Bloomington. Dept. of Geogra-

phy.
D. R. Easterling.
Journal of Climate JLCLEL, Vol. 3, No. 12, p
1380-1389, December 1991. 6 fig, 1 tab, 45 ref.

Descriptors: \*Climatology, \*Mathematical models, \*Meteorology, \*Thunderstorms, \*Weather forecasting, \*Weather patterns, Atmospheric circulation, Data interpretation, Mapping, Regional analysis, Seasonal variation.

Observations of thunderstorm events by months for the period 1948-1977 at 106 stations in the central United States were used to examine persistent spatial patterns in thunderstorm occurrence. Maps of the loadings for the first four unrotated Maps of the loadings for the first four unrotated components closely resemble the patterns suggested by Buell as occurring due to the shape of the study area regardless of the variable analyzed. Standard tests (scree, eigenvalue separation) indicated that the first four principal components, which account for 55% of the domain variance, contain non-random patterns that are uncontaminated in the contains the components. ated by sampling errors. An oblique rotation of the first four components to more precisely define the dominant modes of variability in monthly thunder-storm activity for the summer showed strong loadings on the central portion of the country. The second and fourth components showed a moderate out-of-phase relationship between the northern and southern portions of the study area. Cyclonic and frontal activity figure prominently with the areas of above average thunderstorm activity, and anti-cyclonic activity dominates the areas with below average amounts of thunderstorm activity. A map showing regions defined by assigning each grid point to the rotated component on which it loads the highest is presented. The identification of such coherent regions of thunderstorm activity should conerent regions or funderestorm activity snould prove useful in developing 30-90 day forecasts for the summer months. Also, reducing the temporal resolution and including additional data on static stability and lower-and upper-level flow patterns would help refine these patterns, for useful short-term thunderstorm forecasting. (Medina-PTT) W91-11411

SPRING AND SUMMER 1988 DROUGHT OVER THE CONTIGUOUS UNITED STATES-CAUSES AND PREDICTION.

Scripps Institution of Oceanography, La Jolla, CA.

ate Research Group. J. Namias

J. Namias.

J. Namias.

Journal of Climate JLCLEL, Vol. 4, No. 1, p 54-65, January 1991. 13 fig, 3 tab, 14 ref. NSF Grant ATM 84-07891, USGS Grant 14-08-0001-G1483, and National Climate Program Office Grant NA81AA-D-0054.

Descriptors: \*Climatology, \*Drought, \*Meteorology, \*Precipitation, \*Seasonal variation, \*Weather forecasting, Atmospheric circulation, Climatic data, Model studies, Temperature, Water deficit.

The 1988 summer drought over much of the contiguous United States and its generation from conditions during the preceding spring was analyzed in terms of hemispheric flow patterns in the midtroposphere, temperature and precipitation anomalies, and sea surface temperature anomalies. Conditions in March were especially indicative of the ensuing drought, since a model routinely employed in long-range forecasting showed that the March circulation would most likely be followed by a hot dry April, May, and June over much of the nation—a pattern which persisted into early summer. This result suggests that the initiation of the drought was rooted in extratropical climate variations, an alternative hypothesis to one which attributes the persistent drought-producing circulation to oceanic and atmospheric conditions in the tropics. In many respects the summer drought of 1988 was similar to earlier great droughts of the Great Plains, although it was spatially more extensive. Attempts by three forecast groups to predict the summer conditions from spring's were moderately successful, though none of these anticipated the drought's severity and extent. The underlying reasons for the summer forecast made by the author were verified using objective tools. Premonitory signs showed up in antecedent seasons when deficient precipitation occurred, when climawhen deficient precipitation occurred, when clima-tological contingencies provided alerts, and when extratropical sea surface temperature patterns evolved in a conductive manner. A new modified barotropic model iterating from the May midtro-pospheric height pattern using a mean summer estimate of seasonal forcing produces a reasonably successful estimate of the summer circulation and, in retrospect, even more so when initialized from the March height pattern for the April, May, and June period of inception. (Author's abstract) W91-11412

SPATIAL DISTRIBUTION OF PRECIPITA TION SEASONALITY IN THE UNITE STATES,

Environmental Protection Agency, Research Tri-angle Park, NC. Atmospheric Research and Expo-sure Assessment Lab.

Journal of Climate JLCLEL, Vol. 4, No. 4, p 373-385, April 1991. 12 fig, 2 tab, 33 ref.

Descriptors: \*Climatology, \*Mapping, \*Precipita-tion, \*Regional analysis, \*Seasonal variation, \*Spa-tial distribution, Carbon dioxide, Climatic data, Climatological models, Global warming, Mathe-matical models, Model studies, Temperature.

A very good quality database using spatial aggregated data has allowed the development of a detailed portrait of precipitation seasonality over the United States. Variation of seasonality, decade by decade, has shown that the seasonal precipitation patterns in some areas are very fixed, while others change considerably. This more detailed understanding of the nature of this important climate stanting of the nature of ints important climate variable should assist in the development of better process relationships between climate and regional ecology. A preliminary analysis of the relationship of seasonality to variations in rainfall amount or of sessonality to variations in rainfall amount or annual temperature, do not show any obvious connection in the record. However, global climate models (GCMs) do seem to be able to match certain important aspects of precipitation seasonality over the United States. This would lead one to expect that more careful and quantitative studies of the relationship of seasonality to other climate variables could be done using the GCMs. Scenarios of climates that have been changed by the presence of twice the CO2 found in today's atmosphere produced by several models do suggest that precipitation seasonality could significantly change precipitation seasonality could significantly change in certain parts of the country. Such changes, were they to happen, would have profound effects on natural ecology, agriculture, and water resources; to name but a few areas of critical importance. Since increases in CO2 and other radiatively important trace gases are very real, and contin

#### Precipitation—Group 2B

this result suggests that clear importance of developing a better understanding of how the climate may change, and what the consequences of that change may be. (Medina-PTT) W91-11414

#### FOUR-PARAMETER MODEL FOR THE ESTI-MATION OF RAINFALL FREQUENCY IN SOUTH-WEST ENGLAND,

C. Clark.

Meteorological Magazine MTMGA5, Vol. 120, No. 1423, p 21-31, February 1991. 11 fig, 7 tab, 24

Descriptors: \*England, \*Mathematical models, \*Meteorology, \*Model studies, \*Rain gages, \*Rainfall distribution, \*Rainfall intensity, \*Rainfall rate, \*Weather patterns, Analytical methods, Culverts, Design storms, Flood control, Spillways.

The two best known methods used to estimate the return period (the number of years within which a particular extreme value is likely to be exceeded particular extreme value is likely to be exceeded only once) of rainstorms, namely the Bilham method and that used in Volume II of the Flood Studies Report (FSR-II) produce different results. In general the FSR method gives the higher return periods. This difference is of great practical importance for the design of culverts, flood alleviation schemes, and reservoir spillways. FSR-II grew out of the acknowledged inadequacies of the now largely extinct Bilham method. However, an earlier work by Rootman and Willis showed that for largely extinct blinam method. However, an earni-er work by Bootman and Willis showed that for parts of Somerset, the FSR-II method gave an under-estimation of the magnitude of 2-day rain-fall. This study presents rainfall frequency analysis over the Somerset Division of the Wessex Water over the Somerset Division of the Wessex Water Authority and the South West Water Authority areas in England using a new method for estimating the frequency of heavy rainfall by comparing the number of sites whose return periods are in excess of the 5% probability level of exceedance. It suggests that the large number of rare events as It suggests that the large number of rare events as given by the FSR-II is too high and that the associated FORGE method by Stewart also gives results which suggest that the problem of dependence between widely spaced rain-gages has not yet been overcome. The area was chosen partly because it included the area studied by Bootman and Willis who only considered 2-day rainfall, and also because southwest England is norm to beave; and because southwest England is prone to heavy rainfall. A total of 44 autographic rain-gage records. A comparison of the calculated and observed return periods of storm events showed that the model was capable of giving realistic results and with an accuracy good enough to be used for design purposes. This new method overcomes the problem of intra-Inis new method overcomes the problem of intra-regional variation of growth factors by assigning a growth factor specific for the site in question in contrast to the uniform national growth-curve for the FSR-II and regional curves for the FORGE method. (Medina-PTT) W91-11415

#### SPATIAL DISTRIBUTION OF RAINFALL IN

THE GREATER ATHENS AREA.
National Research Centre for the Physical Scireaction Research Centre for the Inflation concess Democritos, Athens (Greece).
G. T. Amanatidis, C. Housiadas, and J. G. Bartzis.
Meteorological Magazine MTMGA5, Vol. 120,
No. 1424, p 41-50, 1991. 8 fig, 3 tab, 25 ref.

Descriptors: \*Athens, \*Environmental gradient, \*Greece, \*Hypsometric analysis, \*Meteorological data, \*Meteorology, \*Precipitation mapping, \*Rainfall distribution, \*Seasonal variation, \*Weather patterns, Rain gages, Thunderstorms, Topography.

The knowledge of the spatial distribution of rainfall in the Greater Athens Area (GAA) in Greece is limited although rainfall measurements have been carried out in the city of Athens for well over 130 years. The annual and seasonal spatial distribution of rainfall in the GAA was studied from 1985tion of rainfall in the GAA was studied from 1985-1989 using rainfall data from 24 rain-gauges. These rainfall distributions and the temporal variations of rainfall during the 5-year period revealed strong discrepancies among the different parts of the ob-served area. Although the rainfall in the GAA generally presented a seasonal variation with a

maximum during the cold period and a minimum during the warm period of the year, a secondary minimum was observed during winter which intensified with higher rainfall amounts measured in March. The annual rainfall amounts increased with March. The annual rainfail amounts increased with altitude in the GAA by 68.5 mm for each 100 m increase of the station height above sea level. The correlation coefficient between the monthly mean rainfall and the station height showed a seasonal variation with high values during the cold period and low values during the warm period. The annual spatial distribution of rainfall presented a gradient between inland and coastal areas. Consequently, rainfall at Marathon Area doubled as compared with the coastal areas. The same districompared win the coastal areas. In e same distri-bution pattern was observed for January and Octo-ber, while for April and July, the gradient was much less pronounced due to thunderstorm activi-ty, which is less influenced by the local topography. (Medina-PTT) W91-11416

#### KINEMATIC, DYNAMIC, AND THERMODY-NAMIC ANALYSIS OF A WEAKLY SHEARED SEVERE THUNDERSTORM OVER NORTH-ERN ALABAMA.

California Univ., Los Angeles. Dept. of Atmos-pheric Sciences.

pheric sciences.

D. E. Kingsmill, and R. W. Wakimoto.

Monthly Weather Review MWREAB, Vol. 119,

No. 2, p 262-297, February 1991. 26 fig, 75 ref, 3

append. NSF Grant ATM-8703143.

Descriptors: \*Alabama, \*Clouds, \*Meteorology, \*Storms, \*Thermodynamics, \*Thunderstorms, \*Weather patterns, Air masses, Meteorological data, Precipitation, Radar.

On 20 July 1986, a weakly sheared thunderstorm formed over northern Alabama during the Micro-burst and Severe Thunderstorm project. The storm produced a strong, damaging microburst and is believed to be the first well-documented case from a warm-based cloud with a shallow subcould laver. a warm-based cloud with a shallow subcould layer. So far, only numerical simulations of microbursts from these cloud types have been analyzed. During its life cycle a comprehensive dataset was collected with the use of Doppler radar and cloud photography. A kinematic, dynamic, and thermodynamic analysis of this airmass thunderstorm was rade. Most peech live who feet that the domination of the control of the made. Most notable was the fact that the dominant cell in this storm closely resembled the Byers and Braham model for warm-based, airmass storms. Several phenomena never documented for this storm-type was observed. One of these was a strong and deep downdraft recorded at midlevels with an associated weak echo trench. Its origin appeared to be related to a weak entrainment proc-ess. A midlevel inflow which caused a visible constriction in the storm cloud was also observed. This inflow resulted in a division of the thermal This inflow resulted in a division of the thermal buoyancy into two maxima in the vertical: one associated with the precipitation core and the other with strong positive vertical motions in the growing cumulus turret. In addition, a downdraft separate from that seen at midlevels developed at low levels and caused a microburst outflow at the surface. This downdraft appeared to be initiated by precipitation loading and intensified by negative thermal buoyancy. The Byers and Braham model of the cumulus, mature and dissipating stages, was analyzed in light of these new features. (Medina-PTT) PTT W91-11417

## NUMERICAL SIMULATIONS OF THE EVO-LUTION OF A COLD FRONT AND ITS PRE-CIPITATION.

Illinois Univ., Urbana. Lab. for Atmospheric Re-

search.
H. M. H. Juang.
Monthly Weather Review MWREAB, Vol. 119,
No. 2, p 385-411, February 1991. 23 fig. 1 tab, 25
ref. NSF Grants ATM84-15222 and ATM8700778.

Descriptors: \*Meteorology, \*Model studies, \*Precipitation intensity, \*Precipitation mapping, \*Tem-perature gradient, \*Weather patterns, Convective precipitation, Mathematical models, Meteorologi-cal data, Moisture density.

Short-range (36-h) simulations of a surface cold front that occurred over the Great Plains of the Iront that occurred over the Great Plans or the United States during the Severe Environmental Storm and Mesoscale Experiment-Atmospheric Variability Experiment period were made using a significantly modified version of a hydrostatic, sigma-coordinate, quasi-Lagrangian, primitive-equation gridpoint model. The evolution of the environment associated with the cold front was well predicted by the model when compared with went predicted by the model when configured was analyses and observations of the cold front location, horizontal temperature gradient, wind field dry line, temperature inversion, and precipitation. The current model results caught several observed features that were not present in the other mesos-cale model results. The evolution of several local maxima of frontal intensity, defined in terms of temperature gradient, were related to the combination of local maxima of convergence and deformation effects in different locations along the cold tion effects in different locations along the cold front. The genesis of negative relative vorticity along the inverted cold front over the lee of the United States Rockies was related to the effect of solenoidal forcing. The model precipitation agreed well with observation in terms of timing and loca-tion. The evolution of maximum precipitation fol-lowed the evolution of the maximum low-level convergence ahead of the cold front, where ample convergence areas of the controls, where amperiors moisture combined with potential instability. The generation of the temperature inversion in the vicinity of the frontal surface over the southern portion of the cold front prohibited convection there, and localized the frontal precipitation along the northern portion of cold front and east of southern temperature inversion. The temperature inversion was generated by differential temperature advection through the frontal circulation within the PBL, and modified by the vertical stretching effect that stabilized the lower layer behind the cold front and destabilized ahead of the cold front. (Medina-PTT) W91-11418

#### SATELLITE-DERIVED INTEGRATED WATER-VAPOR DISTRIBUTION IN OCEANIC MIDLA-TITUDE STORMS: VARIATION WITH REGION AND SEASON.

Washington Univ., Seattle, Dept. of Atmospheric

L. A. McMurdie, and K. B. Katsaros. Monthly Weather Review MWREAB, Vol. 119, No. 3, p 589-605, March 1991. 12 fig, 3 tab, 41 ref. NASA Contract NAS8-36473 and NASA Grant

Descriptors: \*Climatology, \*Cyclonic precipita-tion, \*Meteorology, \*Remote sensing, \*Satellite technology, \*Seasonal variation, \*Storms, \*Water vapor, \*Weather patterns, Air temperature, Latitudinal studies, Precipitation mapping, Radiometry, Radiosondes, Regional analysis, Water temperature. Weather.

With the atmospheric water-vapor content infor-mation available from the SEASAT and Nimbus-7 mation available from the SEASAL and Nimous-Scanning Multichannel Microwave Radiometers (SMMR), differences in water-vapor distribution between cyclonic storms in different regions of the global ocean can be examined in more detail than previously possible from radiosondes. SMMR-derived integrated water vapor is a robust and de-pendable variable of the same accuracy as integrated radiosonde soundings. In this study, maximum and minimum water-vapor content in the vicinity of cold fronts of 80 storms that occurred in the North Atlantic, North Pacific and Southern oce are compared. North Atlantic storms had signifi-cantly higher maximum and minimum water-vapor content near cold fronts on average than North Pacific or Southern ocean storms for both the warm and cold seasons. These differences are attributed to warmer sea surface temperatures and air temperatures in the North Atlantic, and higher baroclinity and consequently stronger upward motion in North Atlantic storms. Additionally, some of the differences may be attributed to the fact that the North Atlantic storms generally occur at lower latitudes than the storms in the other regions. Furthermore, the North Atlantic storms had significantly higher maximum and minimum water-vapor content near cold fronts on average

#### **Group 2B—Precipitation**

than the Southern Ocean storms for both the warm and cold seasons. These differences are attributable to warmer sea surface temperatures in the North Pacific during the warm season, and to less mois-ture transport by Southern Ocean storms com-pared to North Pacific storms during the cold season. Two examples of water-vapor content in a South Atlantic storm are given to contrast with the Southern Ocean cases. The South Atlantic storm had much higher maximum water-vapor content near the cold front than most Southern Ocean storms. (Author's abstract) W91-11419

SQUALL LINE IN SOUTHERN GERMANY: KINEMATICS AND PRECIPITATION FORMA-TION AS DEDUCED BY ADVANCED POLARI-METRIC AND DOPPLER RADAR MEASURE-MENTS.

Deutsche Forschungsanstalt fuer Luft- und Raum-fahrt e.V., Oberpfaffenhofen (Germany, F.R.). Inst. fuer Physik der Atmosphare. P. F. Meischner, V. N. Bringi, D. Heimann, and H.

Monthly Weather Review MWREAB, Vol. 119, No. 3, p 678-701, March 1991. 22 fig, 1 tab, 47 ref. NSF Grant ATM-8703126 and ATM-8915141.

Descriptors: \*Germany, \*Meteorological data collection, \*Meteorology, \*Precipitation intensity, \*Precipitation mapping, \*Radar, \*Squalls, \*Thunderstorms, \*Weather patterns, Clouds, Hail, Polarization, Rain, Reflectance.

Squall lines are highly organized, long lasting, mesoscale thunderstorm complexes. The main mesoscale thunderstorm complexes. The main characteristic is a line of deep convective cells some 100 km in length forming the leading edge of the system. A multiscale analysis of a squall line system showed that the squall line was initiated as part of a synoptic-scale frontal zone. The main emphasis then is on the polarimetric and Doppler radar measurements which give insight into the mesoscale and microscale structure of the kinematmesoscale and microscale structure of the kineman-ics and the precipitation microphysics especially within the new cells growing ahead of the squall line, and within the main precipitation system. The principal polarimetric measurements considered are the differential reflectivity (Z-DR) and a relat-ed newly derived parameter termed the difference reflectivity or Z-DP which is useful in detection of rain-ice mixed phase precipitation. A limited amount of time series data was analyzed to derive amount of time series data was analyzed to derive the specific differential phase (k-DP) and the backscatter differential phase between horizontal and vertical polarizations. A brief overview of the microphysical interpretation of these parameters is provided. The newly grown clouds were identified as positive Z-DR columns, i.e., regions of low reflectivity and unusually large Z-DR. Within the high reflectivity of the squall line, intense precipi-tation in the form of randforms mixed with smited tation in the form of raindrops mixed with small, melting hail may be inferred. The radar observations were shown to be in good agreement with a hail melting model. A conceptual model of the squall line is provided based on the Doppler and polarimetric data. It demonstrates the internal circulation structure as well as the contribution of melting ice particles to the cold pool dynamics.
(Author's abstract)
W91-11420

SENSITIVITY STUDIES OF TROPICAL STORM GENESIS USING A NUMERICAL

National Oceanic and Atmospheric Administra-tion, Princeton, NJ. Geophysical Fluid Dynamics

Monthly Weather Review MWREAB, Vol. 119, No. 3, p 721-733, March 1991. 9 fig, 28 ref.

Descriptors: "Hurricanes, "Meteorology, "Model studies, "Precipitation mapping, "Storms, "Tropical cyclones, "Weather patterns, Climatology, Evaporation, Numerical analysis, Relative humidity, Synoptic analysis, Temperature, Wind pressure.

A case of developing (Hurricane David) and a case of non-developing disturbance ( did not develop past the depression stage) that occurred a week

apart in the tropical Atlantic in the FGGE year (1979) was analyzed thoroughly with numerical simulations. At one point in their evolution the disturbances had quite similar values of low-level vorticity. In the developing case of Hurricane David, the disturbance propagated along in a lowlevel wave trough with an accompanying high wind maximum. In the non-developing case the initial disturbance was also embedded in a wave initial distributions was also embedded in a wave trough with an associated wind maximum. This low-level wave propagated westward leaving the depression in its wake. The different environmental flow was responsible for the different behavior. Synoptic and budget analyses revealed significant differences in disturbance structure and velocity and equivalent potential temperature tendencies at and equivalent potential temperature reindences at the time of approximate equal strength of the two disturbances. The evolution of these two disturb-ances was quite robust even to reasonable increases to the initial relative humidity. Supplementary experiments of the developing case were performed by altering the sea surface temperature and surface evaporation. The difference in storm evolution was minor in a case when climatological mean values of sea surface temperatures were specified. The climatological mean values were approximately 0.5 K lower than the August 1979 mean used in the control simulation. In addition, an experiment without evaporation led to a propagating easterly without evaporation led to a propagating easterly wave with little development. Furthermore, when the evaporation was specified to a climatological constant value, there was intensification into a weak tropical storm with a rather peculiar structure. Apparently, at least in this case, processes other than evaporation-wind feedback led to moderate storm intensification. (Author's abstract)

CONVECTIVE CELL IN A HURRICANE RAIN-

National Center for Atmospheric Research, Boulder, CO.

G. M. Barnes, J. F. Gamache, M. A. LeMone, and G. J. Stossmeister.

Monthly Weather Review MWREAB, Vol. 119, No. 3, p 776-794, March 1991. 17 fig, 2 tab, 53 ref. NOAA Grants 45-WCNR-5-00388-03 and NR-MGD000-9-01054 (NCAR Proposal No. 83-2).

Descriptors: \*Convective precipitation, \*Hurricanes, \*Meteorological data collection, \*Meteorology, \*Precipitation, \*Radar, \*Storms, \*Tropical cyclones, Clouds, Cyclones, Ice, Rainband, Wind.

On 10 October 1983 the two National Oceanic and On 10 October 1983 the two National Oceanic and Atmospheric Administration WP-3D aircraft com-pleted a mission designed to provide airborne Doppler radar data for a convective cell embedded in a weak rainband on the trailing side of Hurri-cane Raymond. Comparisons of the wind field produced from the pseudo-dual-Doppler radar technique with in-situ wind measurements suggest tecnnique with in-stil wind measurements suggest that the larger convective-scale features may be resolved if the sampling time is kept to a minimum. The convective cell moved downband faster than any environmental winds but slightly slower than the winds found in the reflectivity core that delin-eates the cell. In the core of the cell the tangential wind was increased and the radial inflow turned to outflow with respect to the circulation center. The flow field demonstrated that the downband strati-form portion of a rainband is not from cells currently active since the updraft detrains upwind relative to the cell but rather it is due to the fallout from ice particles placed into the upper tropo-sphere by clouds that have since dissipated. The mass flux of this cell was estimated to be 5%-10% of the mass flux accomplished by an eyewall of a moderate tropical cyclone. This finding supports the concept that large, convectively active rain-bands have a major effect on the subcloud layer air flowing toward the eyewall. (Author's abstract) W91-11422

ASSESSMENT OF VAS-DERIVED RETRIEV-ALS AND PARAMETERS USED IN THUNDER-STORM FORECASTING.

Florida State Univ., Tallahassee. Dept. of Meteor-

ology. H. E. Fuelberg, and S. R. Olson. Monthly Weather Review MWREAB, Vol. 119,

No. 3, p 795-814, March 1991. 13 fig, 3 tab, 34 ref. NASA Grant NAG8-653.

Descriptors: \*Infrared imagery, \*Meteorological data collection, \*Meteorology, \*Precipitation mapping, \*Radiosondes, \*Remote sensing, \*Satellite technology, \*Thunderstorms, \*Weather forecasting, Dewpoint, Humidity, Temperature.

Geostationary meteorological satellites launched by the United States since September 1980 have contained the Visible Infrared Spin Scan Radiome-ter Atmospheric Sounder (VAS). With seven temperature, three water vapor, and two window channels, VAS provides infrared radiances from channels, VAS provides infrared radiances from which vertical profiles of temperature and humidity can be derived. Operational VAS satellite retrievals and derived parameters used in forecasting severe local storms were evaluated against corresponding radiosonde (RAOB) values. VAS products also were compared with the first, suggest input sponding radiosonde (RAOB) values. VAS products also were compared with the first-guess input to the retrieval algorithm. The evaluation methodology was to pair each radiosonde observation (RAOB) with the closest VAS retrieval within 50 km during a 4-month period in 1986. VAS temperatures agreed closely with radiosonde values; however, VAS dewpoints showed somewhat less agreement. VAS/RAOB sounding differences were poorly correlated with the number of pixels from which the retrievals were prepared. A disappointing finding is that the retrievals degraded the first guess about as often as they improved it. Horizontal gradients of VAS products generally were stronger than those from radiosonde. VAS precipitable water agreed better with the ground precipitable water agreed better with the ground truth than did dewpoints at individual levels, but VAS thicknesses were not much improved over the already accurate VAS temperatures. Results for the severe storms forecasting parameters indicated that VAS/RAOB discrepancies increased with the amount of manipulation required during computation. Of all the parameters examined, VAS-derived lifted index exhibited the best agreement with RAOB versions. VAS retrievals provided poor measures of the low-level negative buoyant energy that must be overcome before convecant energy that must be overcome before convec-tion can begin. Agreements between VAS/RAOB versions of the K index, Showalter index, and several other parameters were intermediate to those of positive buoyant energy and lifted index. (Medina-PTT) W91-11423

DYNAMICAL FORCING AND MESOSCALE ORGANIZATION OF PRECIPITATION ORGANIZATION OF PRECIPITATION BANDS IN A MIDWEST WINTER CYCLONIC

Illinois Univ. at Urbana-Champaign. Dept. of Atmospheric Scien

M. T. Shields, R. M. Rauber, and M. H.

Monthly Weather Review MWREAB, Vol. 119, No. 4, p 936-964, April 1991. 19 fig, 2 tab, 36 ref. NSF Grant ATM-8816309.

Descriptors: \*Cyclonic precipitation, \*Illinois, \*Meteorology, \*Precipitation, \*Precipitation mapping, \*Storms, Meteorological data, Radar.

A winter storm that developed over and moved through the midwestern United States on February 10-11, 1988 produced several inches of snowfall locally over east-central Illinois. Analysis of the mesoscale organization of the storm revealed the mesoscale organization of the storm revealed the presence of complex banded structure throughout its 17-h evolution. Three distinct types of mesos-cale precipitation bands were identified during the course of the storm using a 10-cm Doppler radar as part of the University of Illinois Winter Precipita-tion Program. The bands had different orientations, directions of movement, relationships to synoptic-scale frontal zones, and mechanisms of development. The first band type occurred early in the storm along zones of confluence in the surface flow associated with a dissipating frontal boundaflow associated with a dissipating frontal boundary. Convergence along the primary confluence axis produced an extremely narrow but intense mesoscale precipitation band that existed for over 5 h. A second smaller band also was present parallel to the first that was shorter lived. The second type of band developed several hours after the dissipation

#### Snow, Ice, and Frost-Group 2C

of the narrow bands along an inverted pressure trough that separated cool polar and cold arctic air trough that separated cool polar and cold arctic air masses. Strong boundary-layer convergence within an area of frontogenetical forcing along the trough resulted in a region of forced low-level convection that produced the band. The final group of mesoscale precipitation bands was a series of irregularly spaced bands that formed over a surface cold front undergoing frontogenesis. The atmosphere in the region of the bands was characterized by near-neutral conditional symmetric stability. This single case study clearly demonstrated the complex nature of the mesoscale organization of continental cyclonic storms. (Medina-PTT)

APPROACHES TO THE SIMULATION OF RE-GIONAL CLIMATE CHANGE: A REVIEW. National Center for Atmospheric Research, Boul-

der, CO. For primary bibliographic entry see Field 5C. W91-11427

MULTISPECTRAL SATELLITE DATA IN THE CONTEXT OF LAND SURFACE HEAT BAL-

CONTEXT OF LAND SURFACE HEAT BAL-ANCE.

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. For primary bibliographic entry see Field 7B. W91-11428

INTERPRETATION OF HYDROLOGIC EFFECTS OF CLIMATE CHANGE IN THE SACRAMENTO-SAN JOAQUIN RIVER BASIN, CALIFORNIA.

Washington Univ., Seattle. Dept. of Civil Engi-

neering.
For primary bibliographic entry see Field 5C.

ASSESSING THE RESPONSE OF EMERALD LAKE, AN ALPINE WATERSHED IN SEQUOIA NATIONAL PARK, CALIFORNIA, TO ACIDIFICATION DURING SNOWMELT BY USING A SIMPLE HYDROCHEMICAL

Geological Survey, Doraville, GA. Water Re-For primary bibliographic entry see Field 5C. W91-11594

#### 2C. Snow, Ice, and Frost

VAPOR DIFFUSIONAL GROWTH OF FREE-FALLING SNOW CRYSTALS BETWEEN -3 AND -23 C.

Hokkaido Univ., Sapporo (Japan). Inst. of Low Temperature Science.
B. Takahashi, T. Endoh, G. Wakahama, and N.

Journal of the Meteorological Society of Japan JMSJAU, Vol. 69, No. 1, p 15-30, January 1991. 20 fig, 7 tab, 27 ref.

Descriptors: \*Crystal growth, \*Snow, \*Snowfall, \*Vapor diffusion, Diffusion, Precipitation, Snow crystals, Temperature effects.

The characteristics of snow crystal growth by vapor diffusion at water saturation and in free fall were quantitatively investigated in a vertical supercooled cloud tunnel for periods up to 30 minutes at temperatures from -3 to -23 C. The results showed that the basic growth habits were plates (> 4.0 C), columns (-4.0 to -8.1 C), plates (-8.1 to -22.4 C) and columns (<-22.4 C), respectively. At about -5.5, -12, -14.5, -16.5, and -18 C, crystal shapes were enhanced with time. For an isometric crystal, the slope of a log-log plot between the crystal mass and the growth time showed the Maxwellian value of 1.5. The mass growth rate of a shape-enhanced crystal was larger than that of the isometric crystal, indicating more effective vapor transfer on the shape-enhanced crystal. In the case of shape-enhanced planar crystals grown at around -12, -14.5 and -16.5 C, ventilation effects became recognizable, whereas the effect was not evident for needle

crystals grown at about -5.5 C. This suggests that the characteristic length of the flow field even around a needle crystal is along the a-xis. The ventilation effect became significant when the Reynolds number exceeded about 2 (sector) and 5 (dendrite). Linear relationships between the drag coefficient and the Reynolds number were found in log-log plots. (Author's abstract) W91-10515

OBSERVATION OF THE LIQUID WATER CONTENT OF MELTING SNOWFLAKES WITH A NEW INSTRUMENT.

Y. Sasyo, T. Mori, O. Onazaki, and T. Saito. Journal of the Meteorological Society of Japan JMSJAU, Vol. 69, No. 1, p 83-90, January 1991. 4 fig. 1 tab, 6 ref.

Descriptors: \*Measuring instruments, \*Melting, \*Snow, \*Snowflakes, Computer models, Fall velocity, Precipitation, Water content.

In order to measure the liquid water content of a melting snowflake, a new automatic instrument based on a filter paper technique has been devel-oped and used for field observation of sleet. Analyoped and used or held observation of sieet. Analysis of the observational data indicated that the relationship between the liquid water content W and the mass of the snowflake m (mg) could be expressed as W = beta times mass to the negative alpha, where alpha determines the slope of the line alpha, where alpha determines the slope of the line and beta equals the liquid water content of a snow-flake with a mass 1 mg. Alpha ranges from 0.27 to 0.95 (0.53 in an average) and beta ranges from 0.07 to 0.51 (0.25 in an average). A simple model for the melting of snowflakes showed that alpha was a parameter depending on the fall velocity of the snowflake alone and parameter beta depends on the quantity of heat transferred from ambient air to the snowflake and the density of the ice skeleton in the snowflake and the density of the ice skeleton in the melting snowflake as well as the fall velocity. (Author's abstract) W91-10516

GEOCHEMICAL EVIDENCE SUPPORTING T. C. CHAMBERLIN'S THEORY OF GLACIA-

Melbourne Univ., Parkville (Australia). Dept. of

Geology, M. E. Raymo. Geology GLGYBA, Vol. 19, No. 4, p 344-347, April 1991. 1 fig. 54 ref. National Science Foundation Grant No. OCE88-10949.

Descriptors: \*Climatic changes, \*Geochemistry, \*Glaciation, Carbon dioxide, Chemical interactions, Chemical reactions, Climates, Erosion, Orogeny, Strontium radioisotopes, Tectonics,

In 1899, T. C. Chamberlin proposed that the CO2 content of the atmosphere decreased during times of enhanced continental erosion, ultimately resulting in glacial epochs. He ascribed the incre ing in glacial epochs. He ascribed the increase in the rate of chemical weathering (relative to the rate of supply of CO2 from the earth's interior) to increased orogenic activity and globally higher average elevations, which promoted rapid chemi-cal erosion of silicates. The oceanic record of strontium isotopes, preserved in marine sediment, supports his suggestion that glacial climates during the Phanerozoic are in part linked to increases in the rate of global chemical erosion relative to outgassing from the earth's interior. Further, the close correspondence of the major tectonic episodes of the Late Ordovician and Early Silurian, the Devonian, the Carboniferous and the late Ce-nozoic to times of increased continental erosion nozone to times of increased continental evolutions and glaciation suggests that Chamberlin's hypothesis of the cause of glacial periods should be revived. (Author's abstract) W91-10790

SPATIAL AND TEMPORAL INFLUENCE OF SOIL FROST ON INFILTRATION AND ERO-SION OF SAGEBRUSH RANGELANDS. Agricultural Research Service, Boise, ID. Northwest Watershed Research Center.

For primary bibliographic entry see Field 2G. W91-10820

SELF-AFFINE SCALING AND SUBSURFACE RESPONSE TO SNOWMELT IN STEEP TER-RAIN.

Pennsylvania State Univ., University Park. Dept. of Civil Engineering.

For primary bibliographic entry see Field 2G.

W91-10912

EFFECTS OF CLIMATE CHANGE ON DIS-CHARGES AND SNOW COVER IN FINLAND, National Board of Waters, Helsinki (Finland). Water Research Inst.

B. Vehvilainen, and J. Lohvansu Hydrological Sciences Journal HSJODN, Vol. 36, No. 2, p 109-121, April 1991. 7 fig, 10 tab, 6 ref.

Descriptors: \*Climatic changes, \*Finland, \*Global warming, \*Greenhouse effect, \*Model studies, \*Snow cover, Carbon dioxide, Evaporation, Flow discharge, Precipitation, Rainfall-runoff relation-

The effects of climate change obtained through model simulations on runoff and snow cover in Finland have been investigated. The results were based on hydrological model simulations using the information from one climatic general circulation model (GISS) scenario with doubled atmospheric moute (GISS) section with toubled atmospheric carbon dioxide as input. According to the GISS model scenario, the temperature increase in Fin-land will be 2-6 C, the precipitation increase 10-30 mm per month and the evaporation increase 5-30 mm per month. The effects of these climatic changes on runoff and snow cover have been evaluated in twelve different watersheds by hydrological watershed models. According to the results the mean discharge (MQ) increases by 20-50%, the mean minimum discharges (MNQ) increase considerably in winter due to two to three months shorter snow cover period and the mean maximum discharges (MHQ) decrease due to diminished maximum snow water equivalents. In southern Finland persistent winter snow cover will vanish. (Author's abstract)

CLOUD/CRYOSPHERE INTERACTIONS. Lamont-Doherty Geological Observatory, Pali-

sades, NY. For primary bibliographic entry see Field 2B. W91-11095

CLASSIFICATION OF SNOW COVER AND PRECIPITATION USING THE SPECIAL SENSOR MICROWAVE IMAGER.

National Oceanic and Atmospheric Administra-tion, Washington, DC. Environmental Data and Information Service.

For primary bibliographic entry see Field 7B. W91-11219

VARIATION OF THE STABLE ISOTOPES OF WATER WITH ALTITUDE IN THE SAINT ELIAS MOUNTAINS OF CANADA.

National Hydrology Research Inst., Saskatoon (Saskatchewa

(Saskachewan). G. Holdsworth, S. Fogarasi, and H. R. Krouse. Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 96, No. 4, p 7483-7494, April 20, 1991. 13 fig, 54 ref.

Descriptors: \*Altitude, \*Canada, \*Climatology, \*Paleoclimatology, \*Snowmelt, \*Stable isotopes, Atmospheric water, Oxygen isotopes, Snow, St Elias Mountains, Troposphere, Yukon.

Stable isotopes of water, measured in melt samples taken from snow pits and cores at locations be-tween 1750-m and 5930-m altitude on Mount Logan (5951 m) and between 2900 and 4900 m on Logan (5951 m) and between 2900 and 4900 m on Mount Steele (5079 m), in the Saint Elias Mountains, Yukon (Canada), show a distinctive altitudinal distribution. Several delta-18-O and delta-versus altitude profiles indicate the general persistence of a nearly iso-delta step, or staircase structure separating a lower region of altitude-dependent isotopic fractionation between 1750 and 3350 m from another apparent fractionation sequence ap-

#### Group 2C—Snow, Ice, and Frost

pearing above about 5300 m. Both sequences, especially the lower one, indicate orderly processes. On the one hand, postdepositional changes to isotope ratios in snow at different altitudes may cause distortions to an otherwise nearly monotonic iso-tope fractionation sequence, but the main anomaly tope fractionation sequence, but the main anomaly appears to be far too large to be explained in this way. On the other hand, an explanation linked to processes occurring in the lower and midtroposphere is based on established meteorological principles as well as on upper air data. This hypothesis is proposed as the primary one to explain the gross features of the observed isotope profiles. It is committed to the contract of t patible with the concept of secondary-source mois-ture arriving via the upper troposphere, and it does not exclude the effects of postdepositional strati-graphic and stable isotope ratio changes. Over graphic and stable isotope ratio changes. Over interannual time scales, any vertical modulation of the observed isotope-altitude structure, from, for example, changes in wind regime, would give rise to an additional signal in any ice core delta time series. These findings identify a potential difficulty in the interpretation of stable isotope records obtained from high mountain ice core sites. It is possible that the results may have application to atmospheric circulation modeling, where the ef-fects of extreme topography are being studied. (Author's abstract) W91-11220

SUBICE LAYERING AND ORIGIN OF ACIDIC WATERS IN A SMALL BOREAL LAKE DURING THE SPRING RUNOFF.

Institut National de la Recherche Scientifique, Sainte-Foy (Quebec). bibliographic entry see Field 5B.

PERIODIC DRAINAGE OF ICE-DAMMED LAKES AS A RESULT OF VARIATIONS IN GLACIER VELOCITY.

Recele Univ. (England). Dept. of Geography. P. G. Knight, and F. S. Tweed. Hydrological Processes HYPRE3, Vol. 5, No. 2, p 175-184, April/June 1991. 6 fig. 20 ref.

Descriptors: \*Drainage, \*Glacial lakes, \*Glaciers, \*Glaciohydrology, \*Ice, \*Ice-dammed lakes, \*Icedakes, \*Iceland, Glacial drift, Ice breakup, Ice

Previous discussions of the catastrophic drainage of ice-dammed lakes have centered on mechanisms where characteristics of the lake are crucial to drainage initiation, i.e., dam flotation or tunnel formation at a critical lake depth. A different mechanism for lake drainage has been proposed where drainage initiation depends on the charac-teristics of the glacier and is independent of the characteristics of the lake. Prediction of this mechanism must be based on glacier dynamics, whereas the mechanisms most commonly discussed previ-ously are best predicted primarily on the basis of lake evolution. An ice-dammed lake at the margin of the glacier Solheimajokull, in southern Iceland, of the glacier Solheimajokull, in southern Iceland, was observed to drain rapidly into the subglacial or englacial drainage system, supplying water and debris to the bed or interior of the glacier. Geomorphological evidence suggests that the lake drains and refills periodically, discharging up to 13,300 cu m of water into the glacier-hydrological system. The depth of the maximum lake is insufficient to cause either floation of the ice mercinet. ient to cause either flotation of the ice margin or tunnel opening by plastic deformation of the ice. It is suggested that sudden drainage is related to ice-bed separations associated with specific glacier flow states rather than to a critical lake depth threshold. This mechanism of lake drainage has implications for conditions at the glacier bed, for the development of basal ice and for the entrainment of debris into the glacier, as well as for the prediction of potentially hazardous catastrophic drainage events and jokulhlaups from ice-dammed lakes. (Korn-PTT)

SATELLITE-DERIVED REFLECTANCE OF SNOW-COVERED SURFACES IN NORTHERN MINNESOTA.

Aeronautics and Space Administration,

Greenbelt, MD. Goddard Space Flight Center. For primary bibliographic entry see Field 7C. W91-11353

VARIABILITY OF GLACIER MASS BAL-ANCES IN WESTERN NORTH AMERICA. ANCES IN WESTERN NORTH AMERICA. Geological Survey, Tacoma, WA. R. A. Walters, and M. F. Meier. Geophysical Monograph GPMGAD, No. 55, 1989, p 345-374, 9 fig, 4 tab, 37 ref.

Descriptors: \*Climatology, \*Glaciers, \*Mass bal-ance, \*North America, Alaska, Atmospheric circu-lation, British Columbia, El Nino/Southern Oscil-lation, Hydrologic budget, Meteorology, Precipita-tion, Temperature, Washington.

The mass balance of glaciers depends on precipita-tion and temperature in winter and on temperature and insolation in summer. For glaciers in western orth America these meteorological variables are influenced by the large-scale atmospheric circula-tion over the North Pacific Ocean. This study addresses the relation between mass balance at six glaciers in western North America and large-scale atmospheric effects at interannual time scales, and longer-term cumulative changes in glacier volume.

Mass balance data for these glaciers spans 20 years (1966-1985). Similarities and differences between the mass balances are brought out by using empirithe mass balances are brought out by using empirical orthogonal function analysis. Almost 80% of the variance is contained in the first 2 empirical modes (61%, 177%). The first mode shows a negative correlation between the balances for the Alaska glaciers and for the other glaciers. This relation is due to the steering effect of the Aleutian/Gulf of Alaska Low; when it is dry in Washtuni/Guir of Alaska Low; when it is dry in wasnington it is usually wet in Alaska and vice versa. The first mode also shows that dry conditions in Washington and wet conditions in Alaska are associated with a positive Pacific North America (PNA) index and usually with El Nino/Southern Oscillation (ENSO) events. In addition, there was a several-year bias introduced after the 1977 ENSO event that the mass balances in Washington were more negative, and those in Alaska were more positive than before. Over decade time scales the cumulative more before. the cumulative mass balances show an inverse relaune cumuatuve mass balances show an inverse rela-tion between balance at the coastal Alaska glacier and at the southern glaciers. However, the overall trends display a different relation with negative trends at all glaciers except two in the coastal region of British Columbia and Alaska. (Author's abstract) abstract) W91-11391

SNOW AND ICE PERTURBATION DURING HISTORICAL VOLCANIC ERUPTIONS AND THE FORMATION OF LAHARS AND

THE FORMATION OF LATIONS AND ASSESSED A

Descriptors: \*Floods, \*Ice, \*Lahars, \*Mudflows, \*Snow, \*Volcanoes, History, Lava, Melting, Pyroclastic events, Snowmelt, Snowpack.

Historical eruptions have produced lahars and Historical eruptions have produced lahars and floods by perturbing snow and ice at more than 40 volcances worldwide. Most of these volcances are located at latitudes higher than 35 degrees; those at lower latitudes reach altitudes generally above 4000 m. Volcanic events can perturb mantles of snow and ice in at least five ways: (1) scouring and snow and ice in at least five ways: (1) scouring and melting by flowing pyroclastic debris or blasts of hot gases and pyroclastic debris; (2) surficial melting by lava flows; (3) basal melting of glacial ice or snow by subglacial eruptions or geothermal activity; (4) ejection of water by eruptions through a crater lake; and (5) deposition of tephra fall. Historical records of volcanic eruptions at snow-clad volcanoes show the following: (1) flowing pyroclastic debris (pyroclastic flows and surges) blasts of hot gases and pyroclastic debris are the most common volcanic events that generate lahars and floods; (2) surficial lava flows generally cannot melt snow and ice rapidly enough to form large lahars or floods; (3) heating the base of a glacier or anatyracit busined being the control of the c snowpack by subglacial eruptions or by geother-

mal activity can induce basal melting that may result in ponding of water and lead to sudden outpourings of water or sediment-rich debris flows; (4) tephra falls usually alter ablation rates of snow and ice but generally produce little meltwater that results in the formation of lahars and floods; (5) lahars and floods generated by flowing pyroclastic debris, blasts of hot gases and nowing pyroclastic debris, or basal melting of snow and ice commonly have volumes that exceed 100,000 cu m. The glowing lava (pyroclastic flow) which flowed with force over ravines and ridges, gathered in the basin quickly and then forced downward. As a result, tremendously wide and deep pathways in the ice and snow were made and produced great streams of water. (Author's abstract) W91-11394

#### 2D. Evaporation and Transpiration

SALINITY AND EVAPORATION IN THE RIVER MURRAY BASIN, AUSTRALIA. Lamont-Doherty Geological Observatory, Palisades, NY

For primary bibliographic entry see Field 2E. W91-10989

CONCEPT OF EVAPORATION FROM FRESH AND SALINE WATER BODIES.

I. Steinhorn.
Water Resources Research WRERAQ, Vol. 27, No. 4, p 645-648, April 1991. 2 tab, 15 ref.

Descriptors: \*Evaporation, \*Salinity, \*Water level, Errors, Hydrologic budget, Temperature.

Evaporation can be described in several including mass of water molecules converted from liquid to vapor phase, mass of water evaporated per unit area, or as a decrease in water level (or downward movement of the free surface). It is demonstrated that different definitions of evaporation have different implications and meanings de-pending on the specific body of water; these definipenaling of the related equations are not inter-changeable. The error in evaporation estimates that can result from interchanging concepts incor-rectly can be up to 50%. Temperature and salinity rectty can be up to 50%. Temperature and salmity are particularly important. Evaporation results in both loss of water mass and cooling. The effect of cooling is more intensive in a saline lake for both the mass and volume units of the lake, because the energy required to evaporate water is higher. Because of volume variations due to evaporation and other heat sources, it is generally more accurate to use evaporation rate in terms of mass, which is temperature independent. For many applications, the lowering of water level, rather than the evaporation rate, is the parameter of interest. In such cases, it is suggested that the water level be regarded as the outcome of evaporation rather than considered as a measure of evaporation. (Rochester-PTT) W91-11244

RAINFALL INTERCEPTION BY TREES OF PINUS RADIATA AND EUCALYPTUS VIMIN-ALIS IN A 1300 MM RAINFALL AREA OF SOUTHEASTERN NEW SOUTH WALES: I. GROSS LOSSES AND THEIR VARIABILITY. Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Forest Pessearch.

Organization, American Research, E. W. Pook, P. H. R. Moore, and T. Hall. Hydrological Processes HYPRE3, Vol. 5, No. 2, p 127-141, April/June 1991. 6 fig, 4 tab, 24 ref.

Descriptors: \*Canopy, \*Eucalyptus trees, \*Evapo-transpiration, \*Forest ecosystems, \*Interception loss, \*Pine trees, \*Precipitation, \*Rainfall, \*Wales, Australia, Canopy storage, Model studies, Mois-ture, Rainfall intensity, Regression analysis, Stor-age capacity, Wind velocity.

Interception loss (I) is a significant proportion of the total annual evapotranspiration loss from for-ests and it varies widely between different forest types. A change of forest cover type has the impli-cation of a change in magnitude of interception

loss and corresponding predictable effects on water yield. The interception loss was determined by continuous concurrent measurements of the canopy precipitation balances of a mature seed canopy precipitation on banaces of a mature seed orchard tree of Pinus radiata and a dominant tree of Eucalyptus viminalis at a mountainous high rainfall site (900 m a.s.l.) in Tallaganda State Forest of the Upper Shoalhaven Catchment. Approximate of the Upper Shoainaven Caterment. Approximate canopy storage capacity (Sc) of the pine was 1.2 mm, and that of the eucalypt was 0.25 mm. Gross pine I was 26.5 percent and eucalypt I was 8.3 percent of the total incident rainfall over a period 18 months, from June 1975 to December 1976. The exponential model that provided the best fit to overall data relating I to gross rainfall (Pg) showed good precision for the pine (r2=0.73) but rather good precision for the pine (r2=0.73) but rather poor precision for the eucalyty (r2=0.27). A consistent pattern in interception data of the two canopy types suggested that variation in I was related to change in pervasive conditions influencing rates of evaporation from wet canopies during rainfall. Multiple regression analyses confirmed that factors such as rainfall intensity and windthat ractors such as rainfail intensity and wind-speed explained some of the variation in eucalypt, but little in pine I. Negative eucalypt I and corre-sponding low values of pine I over a wide range of Pg (up to 20 mm) suggest that capture of wind-borne precipitation (cloud, mist, or fog) had also complicated the canopy balances. (See also W91-11346) (Korn-PTT)

RAINFALL INTERCEPTION BY TREES OF PINUS RADIATA AND EUCALYPTUS VIMIN-ALIS IN A 1300 MM RAINFALL AREA OF SOUTHEASTERN NEW SOUTH WALES: II. INFLUENCE OF WIND-BORNE PRECIPITA-

Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Forest earch.

Research.
E. W. Pook, P. H. R. Moore, and T. Hall.
Hydrological Processes HYPRE3, Vol. 5, No. 2, p
143-155, April/June 1991. 6 fig, 3 tab, 20 ref.

Descriptors: \*Eucalyptus trees, \*Evapotranspira-tion, \*Interception loss, \*Pine trees, \*Precipitation, \*Rainfall, Australia, Canopy, Canopy storage, Clouds, Fog, Mist, Model studies, Rainfall intensity, Storage capacity, Variability, Wind velocity.

Wide variation of rainfall interception loss (I) is typical of data for storms where gross rainfall (Pg) substantially exceeds canopy storage capacity (Sc) in a variety of forests. Results of previous studies suggests that deposition of unmeasured wind-borne precipitation (i.e., drifting cloud, mist, or fog) associated with rainfall contribute to the variability of Analyses were made of the concurrent canopy precipitation balances of a seed orchard pine and a ature forest eucalypt during protracted rainfalls selected for their representativeness of the range of selected for their representativeness of the range of variation encountered in the two canopy types at Tallanganda State Forest (ca. 990 m a.s.l.) in the Upper Shoalhaven Valley of southeastern New South Wales. Although their canopy storage capacities were widely different there was consistent interception behavior in the pine and the eucalypt in all events. Detailed weather data and the time courses of interception loss provided circumstancourses of interception loss provided circumstan-tial evidence for a varying and, at times, substantial influence of cloud or mist deposition on the canopy precipitation balances during rainfall that made a significant contribution to the variation in rainfall interception data. The results of the investigation indicate a varying mitigating influence of cloud capture on the evaporative loss of rainwater from tree canopies during rainfall. This suggests that in cloud-prone environments, there is a need for careful determination of mist or cloud interception (as well as other components) to achieve more accurate descriptions of forest canopy precipitation balances. (See also W91-11345) (Korn-PTT)

DENDROGEOMORPHIC APPROACH TO ESTIMATING SLOPE RETREAT, MAXEY FLATS, KENTUCKY.

Geological Survey, Reston, VA.
C. R. Hupp, and W. P. Carey.
Geology GLGYBA, Vol. 18, p 658-661, July 1990.

4 fig. 2 tab. 27 ref.

Descriptors: \*Dendrogeomorphology, \*Erosion, \*Geomorphology, \*Kentucky, \*Maxey Flats Disposal Site, \*Radioactive waste disposal, \*Slopes, Bank erosion, Data interpretation, Dendrochronology, Roots, Weathering.

A dendrogeomorphic study of slope retreat was conducted at the Maxey Flats nuclear waste disposal site in northeastern Kentucky. Tree roots exposed by surface lowering were used as an indicator of ground surface at the time of germination. The amount of lowering was measured and divided by tree ring determined age. Surface lowering and slope degradation rates were estimated for d slope degradation rates were estimated for three slopes below waste burial trenches and com-pared with data obtained from sediment troughs and erosion frames at the site. Mean rates of slope retreat ranged from 1.92 to 3.16 mm/yr. Sediment trough results are two to three orders of magnitude than dendrogeomorphic and erosion frame es timates of slope degradation, which suggests that piping and solution-weathering processes may be important factors in slope degradation. Slope aspect and declivity may be important factors affecting retreat of slopes with a uniform lithology. Dendrogeomorphic techniques provide results Dendrogeomorphic techniques provide results comparable to those in the literature and offer a rapid method for estimating slope retreat that inte-grates slope processes over many years. (Author's hstract) W91-11395

#### 2E. Streamflow and Runoff

COMPARISON OF NOCTURNAL DRAINAGE FLOW IN THREE TRIBUTARIES. Argonne National Lab., IL. Environmental Re-

R. L. Coulter, T. J. Martin, and W. M. Porch Journal of Applied Meteorology JAMOAX, Vol. 30, No. 2, p 157-169, February 1991. 11 fig, 3 tab, 9

Descriptors: "Colorado, "Drainage patterns, \*Mountain streams, "Streamflow, "Surface-groundwater relations, "Tributaries, "Water pollu-tion sources, Canyons, Flow, Kimball Cree, Stream banks, Stream discharge, Streams, Wind.

The characteristics of tributary drainage flow in stable, nocturnal conditions in three closely located stable, nocturnal conditions in three closely located tributaries were compared. The orientation of the tributaries with respect to Kimball Creek (Colorado), into which they drain, appeared to be a controlling factor in the tributary flow in drainage conditions was highly dependent upon the surrounding topography, its relationship to the main canyon, and local winds. Well away from the confluence of the south tributaries and Kimball Creek the designer depth was almost as deep the confluence of the south tributaries and Kimball Creek the designer death was almost as deep the confluence of the south tributaries and Kimball Creek the designer death was almost as deep the confluence of the south tributaries and Kimball Creek the designer death was almost as deep the confluence of the confluence of the south tributaries and Kimball Creek the designer death was almost as deep the confluence of the confluence of the south tributaries and Kimball Creek the designer death was almost as deep the confluence of the c Creek, the drainage depth was almost as deep as the sidewalls. Closer to the mouth, however, the depth exceeds the upwind sidewall. Because of convergence of the flows in low levels, much of nage exists 50 m and more above the surface and is quite light. In particular, oscillations in the drainage flow are found to be weakest and drainage mass per unit area greatest in the tributary most closely aligned with the main canyon. W91-10501

OUTFLOW AND THREE-DIMENSIONAL SPREADING OF RIVER WATER IN EN-

Osaka Univ. (Japan). Dept. of Civil Engineering. For primary bibliographic entry see Field 2L. W91-10525

STUDIES ON THE BACTERIAL FAUNA OF THE TAMAGAWA RIVER.

Meiji Coll. of Pharmacy, Tokyo (Japan). Dept. of Microbiology. For primary bibliographic entry see Field 5B. W91-10632

Streamflow and Runoff-Group 2E INTERRELATIONS BETWEEN AMOEBAE AND BACTERIA IN THE MOSELLE RIVER, FRANCE.

Institut Pasteur de Lille, Villeneuve d'Ascq (France). Service des Eaux. For primary bibliographic entry see Field 5B. W91-10650

VIROLOGICAL INVESTIGATION OF THE RIVER ELBE.

Medizinische Akademie 'Carl Gustav Carus' Dres-den (German D.R.). For primary bibliographic entry see Field 5B. W91-10652

ACID-BASE STATUS OF PENNSYLVANIA STREAMS: RESULTS FROM THE NATIONAL STREAM SURVEY. Virginia Univ., Charlottesville.

For primary bibliographic entry see Field 5B. W91-10726

MONTHLY MEAN DISCHARGE AT AND BETWEEN SELECTED STREAMFLOW-GAGING STATIONS ALONG THE MISSISSIPPI, MINNESOTA, AND ST. CROIX RIVERS, 1932-87. Geological Survey, St. Paul, MN. M. E. Schoenberg, and G. B. Mitton. Available from the US Geological Survey, Books and Open-File Reports Section, Box 29425, Federal Center, Denver, CO 80225-0425. Open-File Report 90-186, 1990. 36p, 1 fig, 18 tab.

Descriptors: \*Hydrologic data collections, \*Minnesota River, \*Mississippi River, \*St Croix River, \*Stream discharge, \*Streamflow, \*Wisconsin, Flow velocity, Gaging stations.

Monthly mean discharges for the period of record are given for the streamflow-gaging stations along the upper Mississippi River from its headwaters to Prescott, Wisconsin, as well as for the first up tream streamflow-gaging station on the major tributaries of the Mississippi River, the Minnesota and St. Croix Rivers. Differences in the monthly mean discharge between selected upstream and downstream streamflow-gaging stations are given. The differences were calculated by subtracting the monthly mean discharge from the upstream streamflow-gaging station or stations from the downstream station. The difference is reported at the downstream streamflow-gaging station. (Author's abstract)

UPDATE OF FLOOD-FLOW CHARACTERIS-TICS OF NANCY CREEK AT GEORGIA HIGH-WAY 400 EXTENSION NEAR ATLANTA. GEORGIA

Geological Survey, Doraville, GA.

T. C. Stamey. Available from the US Geological Survey, Books and Open-File Reports Section, Federal Center, Box 25425, Denver, CO 8025-0425. Open-File Report 90-166, 1990. 21p, 9 fig, 3 tab, 12 ref.

Descriptors: \*Atlanta, \*Design floods, \*Flood flow, \*Georgia, \*Highways, \*Nancy Creek, Back-water, Backwater effect, Environmental effects, Flood frequency, Flood profiles.

The Highway Division, Georgia Department of Transportation, has proposed to extend Georgia Highway 400 from Interstate 285 southward to Interstate 85. As part of this extension, the Highway Division would construct a bridge crossing Nancy Creek near Atlanta, and relocate Nancy Nancy Creek near Atlanta, and relocate Nancy Creek at the proposed crossing. The flood-flow characteristics of Nancy Creek near the proposed bridge crossing were evaluated by the US Geological Survey as part of a study conducted in cooperation with the Highway Division. Characteristics studied include: flood frequency, elevation-discharge relations, flood profiles, floodway, and flood-flow effects. Results indicate that the maximum backwater effect for the proposed bridge and relocated channel is 0.2 ft for the 100-year flood. The proposed channel relocation will shorten the

#### Group 2E-Streamflow and Runoff

flow length near the proposed Georgia Highway 400 Extension and reduce the 100-year flood elevation between 1 and 2 feet from existing conditions between the proposed crossing and Windsor Park-way. (Author's abstract) W91-10762

STATISTICAL SUMMARIES OF SELECTED IOWA STREAMFLOW DATA THROUGH SEP-

TEMBER 30, 1988.
Geological Survey, Iowa City, IA.
E.E. Fischer, N. B. Melcher, and S. P. Kluesner.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federial Center, Denver, Co 80225-0425. Open-File Report 90-170, 1990. 641p, 3 fig, 4 tab, 11 ref.

Descriptors: \*Hydrologic data collections, \*Iowa, \*Statistical analysis, \*Streamflow, \*Water resources data, Annual distribution, Graphical analysis, High flow, Low flow, Seasonal variation, Stream discharge, Stream gages.

Statistical summaries of streamflow data collected Statistical summaries of streamflow data collected at 144 active and discontinued stream-gaging stations in Iowa through water year 1988 are presented in the report. The summaries for each stream-gaging station include: (1) station description; (2) the most recent stage-discharge rating table; (3) statistics of monthly and annual mean discharges; (4) boxplots of monthly and annual mean discharges; (5) monthly and annual flow durations; (6) probabilities of annual high discharges; (7) probabilities of annual low discharges; and (8) probabilities of sasonal low discharges. The minimum ities of seasonal low discharges; and (8) probabilities of seasonal low discharges. The minimum period of record at stations included in the report is 10 years. The location of each station is shown on a map of lowa. (Author's abstract) W91-10770

UNIT HYDROGRAPHS FOR DEVELOPING DESIGN FLOOD HYDROGRAPHS.

Illinois State Water Survey Div., Champaign. Office of Surface Water Resources and Systems

Water Resources Bulletin WARBAQ, Vol. 26, No. 6, p 901-911, December 1990. 3 fig, 5 tab, 5 ref.

Descriptors: \*Dam design, \*Design floods, \*Flood forecasting, \*Flood hydrographs, \*Hydrograph analysis, \*Maximum probable floods, \*Unit hydro-graphs, Dam effects, Dam failure, Flood control, Flood recurrence interval, Illinois, Regional analy-

Dam failure caused by overtopping during very high flood conditions results mainly from inad-equate spillway capacity and insufficient freeboard. To avoid underestimation or overestimation of To avoid underestimation or overestimation of design spilluway capacity and freeboard, as well as evaluating the hydrologic safety of existing dams and reservoirs, the satisfactory delineation of unit hydrographs suitable for developing 100-year and up to probable maximum flood (PMF) hydrographs are essential. In Illinois, a procedure has been developed to derive unit hydrographs for corporating 100-year and PMF hydrographs, of the processing 100-year and PMF hydrographs. generating 100-year and PMF hydrographs, on the basis of 11 parameters that define the hydrograph shape very well. Regional regressions of these parameters with basin factors show very high corparameters with oasin factors show very high cor-relation. Thus satisfactory values of parameters can be determined for ungaged areas or those with a few years' record. The nonlinearity in unit hydro-graphs derived from usual floods is largely attrib-uted to mixing within-channel and overbank-flow flood events. (Korn-PTT) W91-10809

MACROPHYTE STANDING CROP AND PRIMARY PRODUCTIVITY IN SOME FLORIDA SPRING-RUNS.

Consejo Superior de Investigaciones Científicas, Gerona (Spain). Centro de Estudios Avanzados de

C. M. Duarte, and D. E. Canfield.
Water Resources Bulletin WARBAQ, Vol. 26, No. 6, p 927-934, December 1990. 2 fig, 2 tab, 23 ref.

Descriptors: \*Florida, \*Light effects, \*Macro-phytes, \*Primary productivity, \*Springs, \*Stand-

ing crops, \*Stream biota, Correlation analysis, Florida springs, Light availability, Light intensity, Light penetration, Light quality, Lotic environ-ment, Nutrients, Riparian vegetation, Rivers, Streams, Submerged macrophytes, Uncertainty, egetation effects.

Florida has a large number of springs, which may represent the largest regional concentration in North America. Most of the springs create flowing water systems called spring-runs that range in size from small streams to large rivers. Previous studies on Florida springs and their associated spring-runs demonstrated that some are among the most productive lotic habitats in the world. However, others were found to be nearly anoxic and unproductive. A survey of 31 Florida spring-runs was conducted to estimate their submerged macrophyte standing crop and primary productivity. The phyte standing crop and primary productivity. The results of the investigation showed that the standing crops of submerged vegetation were not sig-nificantly correlated with either total nitrogen or total phosphorus concentrations, but were signifi-cantly correlated with the percentage of the total pinospirota concentrations, our were signifi-cantly correlated with the percentage of the spring-run's water surface shaded by marginal vegetation. Maximum daily rates of primary pro-ductivity were positively correlated with average submerged macrophyte standing crops and inversely correlated with the degree of shading by marginal vegetation. It should be noted that the marginal vegetation. It should be noted that the daily maximum production values for individual spring-runs should be regarded as relative production values because of the uncertainty associated with some of the calculations. (Korn-PTT) W91-10812

FAST ALGORITHM FOR AUTOMATICALLY COMPUTING STRAHLER STREAM ORDER. Geological Survey, Reston, VA. Water Resources

For primary bibliographic entry see Field 2J.

AQUATIC MACROINVERTEBRATES OF THE ST. FRANCIS SUNKEN LANDS IN NORTH-EAST ARKANSAS.

Forest Service, Glenwood, AR. For primary bibliographic entry see Field 4C. W91-10844

OCCURRENCE OF A SOUTH AMERICAN ARMORED CATFISH IN THE HILLSBOROUGH

RIVER, FLORIDA.
Florida Dept. of Natural Resources, Clermont.
For primary bibliographic entry see Field 2H.
W91-10855

DIEL OXYGEN CYCLE IN THREE SUBAL-PINE SWISS STREAMS.

Zurich Univ., Kilchberg (Swizerland). Hydrobiological-Limnological Station.

For primary bibliographic entry see Field 2H.

W91-10899

FATE OF ACETONE IN AN OUTDOOR MODEL STREAM WITH A NITRATE SUPPLE-MENT, SOUTHERN MISSISSIPPI, U.S.A. Geological Survey, Arvada, CO.

For primary bibliographic entry see Field 5B. W91-10903

SEASONAL CHANGES IN THE SANITARY BACTERIAL QUALITY OF WATER DRAIN-ING A SMALL UPLAND CATCHMENT IN THE YORKSHIRE DALES. Leeds Polytechnic (England). School of the Envi-

For primary bibliographic entry see Field 5B. W91-10935

HYDROLOGICAL BALANCE OF TWO MEDITERRANEAN FORESTED CATCHMENTS (PRADES, NORTHEAST SPAIN).
Barcelona Univ. (Spain). Dept. de Ecologia.

For primary bibliographic entry see Field 2A. W91-10963

MAXIMUM ENTROPY VIEW OF PROBABILI-TY-DISTRIBUTED CATCHMENT MODELS. Heriot-Watt Univ., Edinburgh (Scotland). Dept. of

Civil Engineering. For primary bibliographic entry see Field 2A. W91-10965

RUNOFF ANALYSIS OF THE CHANG JIANG (THE YANGTZE RIVER).

6-13-30 Mihama Tokyo 157, Japan. Mihamai Karasuyama, Sebagaya-ku,

M. Sugawara, and E. Ozaki. Hydrological Sciences Journal HSJODN, Vol. 36, No. 2, p 135-152, April 1991. 15 fig, 10 tab, 3 ref.

Descriptors: \*China, \*Discharge hydrographs, \*Flow discharge, \*Hydrologic models, \*Model studies, \*Rainfall-runoff relationships, \*Runoff forecasting, Catchment areas, Daily hydrographs, Discharge capacity, River basins, Yangtze River.

The daily discharge of the Chang Jiang (the Yangtze River) at Yichang (catchment area about one million square kilometers), downstream of Three Gorges in China, has been derived by routing the daily discharge of the Jinsha Jiang at Pringshan (catchment area about half a million square kilometers) with modeled runoff based on square kilometers) with modeled runoff based on daily precipitation at 14 rainfall stations in the downstream Sichuan basin. Precipitation at each station was transformed into runoff by means of a tank model composed with a time lag. The time lag was assumed to obey a normal distribution, the mean and the standard deviation of which were determined by the discharge on the same day at Three Gorges. Fourteen series of calculated runoffs were combined with weights to combine runoff derived from precipitation at each station in order to calculate the runoff from the Sichuan basin. The calculated Yichang discharge was derived by combining the calculated runoff from the Sichuan basin and the transformed Pingshan discharge with time lag, with weights proportional to charge with time lag, with weights proportional to the respective catchment areas. Finally, the monthly mean hydrograph and the daily hydrograph were derived by the final model. The observed and calculated monthly mean and daily discharges were found to agree closely. (Fish-PTT) W91-10966

DYNAMIC-STOCHASTIC MODELS OF RAIN-FALL AND SNOWMELT RUNOFF FORMA-TION,

Akademiya Nauk SSSR, Moscow. Inst. Vodnykh For primary bibliographic entry see Field 2A. W91-10967

SIMILARITY SOLUTIONS OF THE SHALLOW WATER EQUATIONS. Reading Univ. (England). Dept. of Mathematics.

For primary bibliographic entry see Field 8B. W91-10987

SALINITY AND EVAPORATION IN THE RIVER MURRAY BASIN, AUSTRALIA.

Lamont-Doherty Geological Observatory, Pali-

Saucs, IVI.

H. J. Simpson, and A. L. Herczeg.
Journal of Hydrology JHYDA7, Vol. 124, No. 1/
2, p 1-27, April 1991. 9 fig, 6 tab, 35 ref. AustralianAmerican Educational Foundation (Fulbright Program), US National Science Foundation (grant no.
INT-88-14385), and CSIRO.

Descriptors: \*Australia, \*Evaporation, \*Irrigation effects, \*Murray-Darling River Basin, \*River basins, \*Saline water, \*Solute transport, Aeration zone, Chlorides, Deuterium, Flow discharge, Irrigation water, Precipitation, Reservoir evaporation, Saline groundwater, Surface runoff.

The River Murray in Australia discharges only 4% of annual precipitation delivered to the Murray Basin. Flow gaging and water composition data over an 18-year period (1971-1989) indicated that median annual transport of chloride out of the basin was 2.6-4.1 times that delivered annually by

#### Streamflow and Runoff-Group 2E

the atmosphere to surface runoff plus inflow from the atmosphere to surrace runoff puis minow from the tributary Darling River. The additional salt flux out of the River Murray was apparently de-rived primarily from saline groundwater plus mo-bilization by irrigation drainage of salt stored within the unsaturated zone. During March 1989, towards the end of a dry summer, the deuterium composition of water near the river mouth was -4 per thousand, compared with -43 per thousand in the largest headwater catchment. Most of this heavy isotope enrichment was the result of evapo-ration from reservoir and river surfaces plus inflow of irrigation drainage water. The trend in deuteri-um values along the river axis suggests that a large component of the chloride increase in the middle third of the river was derived from irrigation drainage whereas the further increase of chloride drainage whereas the further increase of chloride in the downstream third of the Murray was derived primarily from influx of saline groundwater. Evaporative enrichment appears to play a major role in the seasonal and geographical trends of stable isotope composition in the River Murray. The total deuterium enrichment observed indicates that integrated exponention losses in the basis in the hosting the properties of the control of the con that integrated evaporation losses in the basin are similar in magnitude to transpiration losses during the months of intensive irrigation. (Author's abstract) W91-10989

REGIONAL APPROACH TO DROUGHT PLANNING AND MANAGEMENT IN THE GREAT LAKES BASIN.

Great Lakes Basin Commission, Ann Arbor, MI. For primary bibliographic entry see Field 6A. W91-11012

EXPORTING HIMALAYAN FLOODS.
California Univ., Santa Barbara. Center for Remote Sensing and Environmental Optics. R. Kattelmann.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 101-110, 50

Descriptors: \*Bangladesh, \*Flood basins, \*Flood control, \*Himalayan Mountains, \*International waters, Brahmaputra River, Dams, Floods, Ganges River, India, Nepal, Reforestation.

The catastrophic flooding in Bangladesh in September 1988 largely resulted from runoff generated beyond its borders. Politicians in the region and news media around the world have blamed the high water on degraded conditions in the Himala-yan headwaters of rivers tributary to the Ganges yan headwaters of rivers tributary to the Ganges and Brahmaputra. Such claims are provoking conflict at a time when Bangladesh, India, and Nepal are involved in negotiations about the region's water resources. However, there is no scientific basis for relating the largest floods in major rivers to upstream land use. Although watershed conditions can have dramatic influences on storm flow tions can have dramatic influences on storm loop peaks of moderate frequency in small basins, rare storms of high intensity and long duration general-ly overwhelm available watershed storage. De-mands for a network of flood control dams and massive reforestation in the Himalayan foothills may avoid the more critical problems in the lowlands. Mitigation measures based on a faulty per-ception of the Himalayan hydrologic system are likely to fail. This flood controversy demonstrates the urgent need to share hydrologic data through-out the region and improve understanding of this international river system. (See also W91-11003) (Author's abstract) W91-11014

FLOOD FORECASTS ON TRANSBOUNDARY RIVERS IN HUNGARY WITH PARALLELS IN CANADA.

Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary).
For primary bibliographic entry see Field 4A.
W91-11015

COMPARISON OF MEAN ANNUAL RUNOFF ESTIMATES IN THE CANADIAN PORTION OF THE GREAT LAKES BASIN.

Environment Canada, Guelph (Ontario), Water Resources Branch. H. Goertz.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 159-170, 10 fig, 2 tab, 7 ref.

Descriptors: \*Annual runoff, \*Data interpretation, \*Great Lakes Basin, \*Rainfall-runoff relationships, \*Runoff forecasting, \*Streamflow, \*Water supply, Comparison studies, Hydrologic data, Precipitation, Runoff, Watersheds

A major component of the water supply to the Great Lakes is contributed from the streams and rivers in the watershed. The measurement of river rivers in the watershed. The measurement of river flows at a network of several hundred gauging stations throughout the watershed and over several years allows the quantitative assessment of various hydrologic parameters including Mean Annual Runoff, MAR. Several regional estimates of MAR for the Canadian portion of the Great Lakes Basin have been prepared since 1965. The consistency among the various MAR estimates was investigated, by comparing MAR estimates with each other and with the data of river flow gauging stations. MAR data was calculated from recorded river flow data for approximately 300 stations and extracted from the MAR maps of six previous studies. The results indicate a difference among various MAR estimates of up to 17% on average between certain studies. The results indicate a significant effect due to the period of record of data sets used certain studies. The results indicate a significant effect due to the period of record of data sets used in the calculation of MAR estimates. Under-estimation or over-estimation of MAR can impact technical designs and economic decisions. (See also W91-11003) (Author's abstract)

EFFECTS OF CHANGES IN LAND USE ON ANNUAL STREAMFLOWS IN THE LAKE HURON BASIN OF CANADA AND THE UNITED STATES.

Geological Survey, Reston, VA. For primary bibliographic entry see Field 4C. W91-11021

COMPREHENSIVE WATER MANAGEMENT STRATEGY: CREDIT RIVER WATERSHED.

Triton Environmental Consultants Ltd., Burnaby (British Columbia). For primary bibliographic entry see Field 6A. W91-11043

GEOHYDROLOGY AND WATER QUALITY OF KALAMAZOO COUNTY, MICHIGAN, 1986-

Geological Survey, Lansing, MI. Water Resources For primary bibliographic entry see Field 2F. W91-11091

TECHNIQUES FOR ESTIMATION OF STORM-RUNOFF LOADS, VOLUMES, AND SELECTED CONSTITUENT CONCENTRATIONS IN URBAN WATERSHEDS IN THE UNITED STATES.

Geological Survey, Lakewood, CO. Water Resources Div. For primary bibliographic entry see Field 5B. W91-11094

TRANSPORT AND FATE OF ACETONE IN AN OUTDOOR MODEL STREAM, STENNIS SPACE CENTER NEAR BAY ST. LOUIS, MIS-

Geological Survey, Denver, CO. Water Resources For primary bibliographic entry see Field 5B. W91-11103

CHANNEL AND BANK STABILITY OF WOLF CREEK AND A TRIBUTARY AT U.S. HIGH-WAY 45 NEAR WHEELER, PRENTISS COUNTY, MISSISSIPPI. Geological Survey, Jackson, MS. Water Resources

Div K. Van Wilson, and D. P. Turnipseed. Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 90-110, 1990. 18p, 5 fig, 3 tab, 24 ref.

Descriptors: \*Bank erosion, \*Bank stabilization, \*Channel degradation, \*Erosion, \*Wolf Creek, Channels, Streams, Vegetation.

The channel of Wolf Creek at the existing and proposed US Highway 45 relocation near Wheeler, Mississippi, has degraded about 8 ft and widened about 122 ft since it was channelized in about 1912. Channel degradation of a small tributary to Wolf Creek has totaled about 2 ft in the vicinity of the proposed relocation. Botanical evidence indicates that several recent bank failures downstream from broposed reiocation. Bolamical evidence indicates that several recent bank failures downstream from the proposed relocated crossing of Wolf Creek occurred as a result of floods in 1973, 1977, and 1987-88. Rates of channel gradation and widening-as determined from channel descriptions and botanical evidence along the banks-were used in conjunction with soil properties to estimate probable future channel degradation and widening through the year 2010. By assuming that channel bed elevations can be expressed as a power function with time, additional channel degradation hrough the year 2010 could approach 3 ft at the existing and at the proposed crossing of Wolf Creek. No further significant degradation is expected at the proposed crossing of the small tributary to Wolf Creek. The bankfull channel width of Wolf Creek at the existing and at the proposed crossing could increase about 30 ft by the year 2010. The channel width of the northern tributary at the proposed crossing could increase about 10 ft at the proposed crossing could increase about 10 ft in the next 10 to 20 years. These projections are based on the assumption that no additional channel modifications and no unusually large and destructive flooding will occur by the year 2010. (Author's abstract) W91-11107

EFFECTS OF THE 1988 DROUGHT ON WATER RESOURCES IN WISCONSIN.

B. K. Holmstrom, and B. R. Ellefson. Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 90-149, 1990. 2p, 4 fig, 4

Descriptors: \*Drought effects, \*Hydrologic budget, \*Water deficit, \*Wisconsin, Agriculture, Domestic water, Drought, Groundwater re-sources, Industrial water, Irrigation, Municipal water, Streamflow, Surface water, Water quality, Water shortage, Water supply, Wind Lake.

The 1988 drought was one of the most severe droughts since weather records have been kept in Wisconsin; precipitation in Wisconsin was below normal in most areas during the 1988 calendar year. The statewide precipitation average of 25.7 inches for the year was 5.6 inches below the normal precipitation of 31.2 inches; 1988 was the 14th driest year since 1840. Annual runoff during the 1988 water year (October 1, 1987 to September 30, 1988) was below normal (long-term average) in the entire State, except for a few basins in south-central and southeastern Wisconsin, where runoff was 101% of normal. The water quality of many eutrophic (enriched) lakes improved because of reduced nutrient loadings. In response to this nutri-ent reduction, phosphorus concentrations in water near the lake surface declined, resulting in a substantial improvement in the lake's water quality. Record or near record low water levels were Record or near record low water levels were measured in about 50 observation wells during 1988. These low water levels are similar to those measured during the 1978 drought. The amount of water used for irrigation during 1988 increased because the drought occurred during the growing season. Groundwater accounts for approximately 98% of the water used for irrigation, and permit applications to construct new irrigation wells in 1988 increased by 95% for the period June-August. During 1988, the supply of water was usually adequate to operate all irrigation systems. Wisconsin has about 550 public water supply systems that

#### Group 2E-Streamflow and Runoff

serve approximately 65% of the State's population. Groundwater is used as a source of 495 systems and the remaining systems either purchase water form larger suppliers or use surface water. Groundwater supplies were adequate during the 1988 drought, but in many communities water use restrictions were imposed for uses such as watering lawns and washing cars. The use of surface water for self-supplied industrial and thermoelectric purposes increased during the 1988 drought, necessitating the need for some withdrawal restrictions poses increased during the 1986 drought, necessi-tating the need for some withdrawal restrictions because of low streamflow and inadequacy of sur-face water supplies. A large deficit in rainfall from April through mid-July 1988 and unusually high temperatures from June through August produced drought conditions that stressed crops and caused crop-related losses. Drought appraisals indicated that drought-related crop losses in the State in 1988 exceeded \$900 million. (Lantz-PTT) W91-11108

AUTOMATIC TRACER-DILUTION METHOD USED FOR STAGE-DISCHARGE RATINGS AND STREAMFLOW HYDROGRAPHS ON SMALL IOWA STREAMS.

Geological Survey, Iowa City, IA. Water Resources Div.

For primary bibliographic entry see Field 7B. W91-11111

#### GEOMORPHOLOGICAL DISPERSION.

Trento Univ. (Italy). Dipt. di Ingegneria Civile e

A. Rinaldo, A. Marani, and R. Rigon. Water Resources Research WRERAQ, Vol. 27, No. 4, p 513-525, April 1991. 12 fig, 31 ref, 2

Descriptors: \*Channel networks, \*Dispersion, \*Geomorphology, \*Hydrodynamics, \*Hydrology, \*Rainfall-runoff relationships, \*Runoff, Catchment areas, Channel flow, Hydraulics, Model studies, Topology, Traveltime.

The hydrologic response of a channel network is defined by decomposing the process of runoff for-mulation into two distinct contributions, one ac-counting for the mechanisms of travel time within individual reaches (hydrodynamic dispersion), and the other accounting for the morphology of the network structure (geomorphological dispersion). Exact Laplace transforms of first passage time distributions at the outlet of a network are obtained by a consistent approximation of travel time distri-butions through individual reaches. The moments of such distributions are obtained analytically in the general case. Closed-form, first-passage distri-butions are obtained in the particular case of basinconstant hydrodynamic dispersion. The variance of the resulting travel time distributions is shown here to consist of two additive contributions corre sponding to the two dispersion mechanisms cons sponding to the two dispersion mechanisms considered. The geomorphologic dispersion coefficient is shown to depend on the ratios of bifurcation, length, and area of the network, suggesting that at the scale of an organized network, heterogeneities other than those related to the convection field shape the dispersive character of transport. In particular, a significant application of the general solution to Hortonian channel networks suggests that models based on accurate specification of the ge-ometry and the topology of the networks and a simplified dynamics capture the foremost features of the travel time distributions in a broad range of dispersivities within individual reaches. (Author's abstract) W91-11232

EVALUATION OF ANALYTICAL SOLUTIONS TO ESTIMATE DRAWDOWNS AND STREAM DEPLETIONS BY WELLS. GeoTrans, Inc., Herndon, VA.

For primary bibliographic entry see Field 2F. W91-11240

STREAM CHEMISTRY IN THE EASTERN UNITED STATES: 1. SYNOPTIC SURVEY DESIGN, ACID-BASE STATUS, AND REGION-

Utah Water Research Lab., Logan. For primary bibliographic entry see Field 5B. W91-11241

KNOWLEDGE-BASED SYSTEMS AND OPER-ATIONAL HYDROLOGY.
Manitoba Univ., Winnipeg. Dept. of Civil Engi-

neering. For primary bibliographic entry see Field 7C. W91-11273

COMPUTATION OF UNIFORM FLOW IN OPEN CHANNELS WITH FLOOD PLAINS. Technical Univ. of Nova Scotia, Halifax. Dept. of

Civil Engineering.
M. G. Satish, Y. Guo, and M. Rahman.
Canadian Journal of Civil Engineering CJCEB8,
Vol. 18, No. 1, p 149-155, February 1991. 7 fig, 2

Descriptors: \*Flood plains, \*Flow equations, \*Flow models, \*Mathematical models, \*Model studies, \*Open-channel flow, \*Streamflow, \*Uniform flow, Friction stress, Kappa-epsilon model, Momentum equation, Numerical analysis, Shear

Two-dimensional depth-averaged mathematical models have been used to compute the flow char-acteristics in open channels with flood plains. A depth-averaged version of the kappa-epsilon acteristics in open channels with flood plants. A depth-averaged version of the kappa-epsilon model, including the term that accounts for the effect of the submerged vertical or steep boundaries on the flow characteristics in the momentum equation, was devised. Inclusion of this term plays equation, was devised. Inclusion of this term plays an important role in the distribution of the computed eddy velocity in the interaction region between the flood plain and the main channel. The results of a numerical study as well as testing of the numerical model against two sets of experimental data validated the model. Two-dimensional depth-averaged models using the kappa-epsilon turbulent shear stress can be used to predict the flow characteristics in a channel with compound cross section. In using the model, none of the empirical coefficients were tuned to match the experimental results, but were obtained from the literature. The results, but were obtained from the literature. The approximation of the friction stress on the submerged vertical wall used here proved appropri-ate. When a channel of compound cross section, comprising submerged, vertical, or steeply inclined walls, is to be modeled by a two-dimensional depth-averaged mathematical model, it is necessary to include in the momentum equation th terms that, because of the varying elevation of the channel bottom, emerged from the integration pro-cedure along the transverse direction of the horizontal momentum equations. (Rochester-PTT)

CORRECTION COEFFICIENTS FOR UNIFORM CHANNEL FLOW.
Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Wasserbau, Hydrologie und Glaziologie.
D. Li, and W. H. Hager.
Canadian Journal of Civil Engineering CJCEB8, Vol. 18, No. 1, p 156-158, February 1991. 2 fig, 22

Descriptors: \*Correction coefficients, \*Flow equations, \*Open-channel flow, \*Streamflow, \*Uniform flow, Kinetic energy, Literature review, Mathematical equations, Momentum, Theory, Velocity.

The effect of assuming uniform velocity distribution on energy and momentum considerations is a controversial problem of long history. Literature on this topic is reviewed and uniform open channel flow is considered. Experiments conducted both in model and prototype channels were used to confirm propositions going back to the 1940s. It is found both theoretically and experimentally that the kinetic energy and momentum correction coef-ficients depend significantly on the Manning roughness coefficient and that the kinetic energy correction coefficient may be related directly to the momentum correction coefficient. Further, the effect of local variation of correction coefficients is

much smaller than the variation of dynamic pres sures times the correction coefficient. Therefore, a previously proposed concept of constant coeffi-cient is justified. (Rochester-PTT) W91-11282

STREAMFLOW GENERATION IN A HEAD-WATER BASIN ON THE PRECAMBRIAN SHIELD.

Trent Univ., Peterborough (Ontario). Watershed Ecosystems Program.
C. Wels, C. H. Taylor, R. J. Cornett, and B. D.

Lazerte. Hydrological Processes HYPRE3, Vol. 5, No. 2, p 185-199, April/June 1991. 8 fig, 2 tab, 30 ref.

Descriptors: \*Headwaters hydrology, \*Overland flow, \*Rainfall-runoff relationships, \*Runoff, \*Storm seepage, \*Streamflow, Canada, Hydro-graphs, Mapping, Saturated soils, Stream discharge, Tracers.

Current conceptual runoff models hypothesize that stormflow generation on the Canadian Shield is a combination of subsurface stormflow and saturation overland flow. This concept was tested during spring runoff in a small (3.3 ha) headwater basin using isotopic and chemical hydrograph separation as well as field mapping and direct tracing of saturated areas. Isotopic and chemical hydrograph separation indicated three runoff components: (1) pre-melt subsurface flow; (2) subsurface flow of new (event) water; and (3) direct precipitation onto saturated areas (DPS). During early thawfreeze cycles, their relative contributions to total flow remained constant (65 per cent, 30 per cent, and 5 per cent, respectively). It is hypothesized that lateral flow along the bedrock/mineral soil interface, possibly through macropores, supplied large volumes of subsurface flow (of both old and new water) rapidly to the stream channel. Much higher contributions of DPS were observed during an intensive rain-on-snow event (15 per cent of total flow). Mapping and direct tracing of saturated areas using lithium bromide, suggested that saturated area size was positively correlated to stream discharge, but its response lagged behind that of discharge. These observations suggest that the runoff mechanisms, and hence the sources of stream flow, will vary depending on storm characteristics. (Author's abstract) Current conceptual runoff models hypothesize that stream flow, will vary depending on storm charac-teristics. (Author's abstract) W91-11349

STUDIES OF SPRINGS IN THE SOUTHERN PART OF THE VALLEY OF MEXICO (ESTUDIO CRENOLOGICO EN LA PARTE MERIDIONAL DE LA CUENCA DE MEXICO).

Wroclaw Univ. (Poland). Inst. Geograficzny J. Tomaszewski, R. Huizar-Alvarez, S. Marin-Cordoba, and J. Mandujano-Velazquez. Instituto de Geologia Revista RUNGD7, Vol. 8, No. 2, p 223-234, 1989. 19 fig, 2 tab, 9 ref. English

Descriptors: \*Aquifers, \*Drainage, \*Geohydrology, \*Groundwater movement, \*Mexico, \*Runoff, \*Springs, Chemical composition, Climatology, Gravity springs, Recharge, Spring water, Tectonics, Volcanic springs.

A study has been undertaken to examine the general characteristics of the different kinds of crenologic and potamologic drainage existing in the volcanic areas of the southern part of the Basin of Mexico, as well as the kind of aquifers that recharge them. The springs and runoffs are divided into several types, based on the following parameters: (1) forces causing the movement (i.e., gravity and pressure), (2) type of aquifer, (3) origin and chemical composition of the water, (4) yield variation, (5) morphology, (6) climate, and (7) tectonics of the area. The characteristics of these water discharges on the surface are described on the basis A study has been undertaken to examine the generof the area. The characteristics of these water discharges on the surface are described on the basis of the general circulation scheme of groundwater proposed for the studied area. From the hydrogeo-themical point of view, the mineral concentration is low and, therefore, the water is classified as fresh. It is concluded that the water recharging the aquifer is mainly meteoric in origin. The hydrodynamics of springs and runoff areas are analyzed on the basis of hydrologic measurements made in the field and available statistical information. This permits the grouping of the springs in the studied area into classes V, VI, and VII, based on the Meinzer classification scheme. (Author's abstract)

PALEOHYDROLOGIC TECHNIQUES USED TO DEFINE THE SPATIAL OCCURRENCE OF FLOODS.

Geological Survey, Denver, CO. R. D. Jarrett.

Geomorphology, Vol. 3, p 181-195, 1990. 12 fig, 2 tab, 28 ref.

Descriptors: \*Flood forecasting, \*Flooding, \*Floods, \*Geomorphology, \*Paleohydrology, \*Spatial variation, Flood discharge, Flood frequency, History, Hydrometeorology, Peak flow, Rainfall, Regional analysis, Streamflow.

Defining the cause and spatial characteristics of floods may be difficult because of limited stream-flow and precipitation data. New paleohydrologic flow and precipitation data. New paleohydrologic techniques that incorporate information from geomorphic, sedimentologic, and botanic studies provide important supplemental information to define homogeneous hydrologic regions. These techniques also help to define the spatial structure of rainstorms and floods and improve regional flood frequency estimates. The occurrence and the non-occurrence of naleohydrologic evidence of floods. occurrence of paleohydrologic evidence of floods, such as flood bars, alluvial fans, and tree scars, provide valuable hydrologic information. This paleohydrologic research to define the spatial characteristics of floods improves the understanding of flood hydrometeorology. This type of research was used to define the areal extent and contribut-ing drainage are of flash floods in Colorado. Paleohydrologic evidence was also used to define the spatial boundaries for the Colorado foothills region in terms of the meteorologic cause of flooding and elevation. In general, above 2300 m, peak flows are caused by snowmelt. Below 2300 m, peak flows are primarily are caused by rainfall. The foothills region has an upper elevation limit of about 2300 m. and a lower elevation limit of about 1500 m. Reand a lower elevation limit of about 1500 m. Regional flood frequency estimates that incorporate the paleohydrologic information indicate that the Big Thompson River flash flood of 1976 had a recurrence interval of approximately 10,000 yrs. This contrasts markedly with 100 to 300 yrs determined by using conventional hydrologic analyses. Flood discharge estimates based on rainfall-runoff methods in the foothills of Colorado result in larger values than those estimated with regional methods in the footnills of Colorado result in larger values than those estimated with regional flood frequency relations, which are based on long-term streamflow data. Preliminary hydrologic and paleohydrologic research indicates that intense rainfall does not occur at higher elevations in other Rocky Mountain states, and that the highest eleva-tions for rainfall-producing floods vary by latitude. (Author's abstract) W91-11396

SPRING AND SUMMER 1988 DROUGHT OVER THE CONTIGUOUS UNITED STATES-CAUSES AND PREDICTION.

Scripps Institution of Oceanography, La Jolla, CA. Climate Research Group. For primary bibliographic entry see Field 2B. W91-11412

REGULATORY INFLUENCE OF WATER CUR-RENT ON ALGAL COLONIZATION IN AN UNSHADED STREAM AT SHILLONG (MEGH-ALAYA, INDIA). North-Eastern Hill Univ., Shillong (India). Dept.

of Botany.
M. Ghosh, and J. P. Gaur.
Aquatic Botany AQBODS, Vol. 40, No. 1, p 37-46,
April 1991. 2 fig, 3 tab, 33 ref.

Descriptors: \*Algae, \*Colonization, \*Diatoms, \*Ecological distribution, \*Flow velocity, \*India, \*Stream biota, \*Water currents, Chlorophyll a, Ecosystems, Gomphonema, Hydrogen ion concentration, Navicula, Periphyton, Phosphorus, Physiological ecology, Population density, Riffles, Species composition, Streamflow.

The effects of current flows on periphytic algae were investigated in a spring-fed stream in Shillong (India). The experiment was carried out in March-April 1989, when there had been no rain and the stream was at its base flow. Analysis of stream water revealed a marked similarity in the chemical experiments of the need of the stream water revealed a marked similarity in the chemical stream. water revealed a marked similarity in the chemical properties of the pool and riffle zones. Initially, cell density was similar in the pool and at low flow. It declined in the pool with the lapse of time. The amount of chlorophyll a in the pool and at high flow showed no marked difference until the third week, but a slight rise occurred in the fourth week. Algal communities developing on artificial substrate in a pool as well as three riffle habitats (flow rates of 10-15, 18-22, and 37-41 cm/s) were composed only of diatoms. The stream supported scant diatom flora (27 genera in 9 species), possibly due to low pH and phosphorus-limiting conditions. In general, algal colonization was negatively related to flow rate, and was best at 10-15 cm/s. Different diatom species assumed dominance at specific flow rates: Navicula subtenelloides at 10-15 cm/s, Gomphonema parvulum and Caloneis ventricosa at 18-22 cm/s, and Synedra ulna at 37-41 cm/s. In the pool, Eunotia pseudoparallela and week, but a slight rise occurred in the fourth ventricosa at 18-22 cm/s, and Synedra ulna at 37-41 cm/s. In the pool, Eunotia pseudoparallela and Gomphonema olivaceum were most abundant. It is concluded that water current exerts a profound effect on the dynamics of algal colonization in streams. Future investigations on such algae should always define flow conditions to give the results ecological relevance. (Doria-PTT)

IMPACT OF A PULSE APPLICATION OF PERMETHRIN ON THE MACROINVERTEBRATE COMMUNITY OF A HEADWATER STREAM. Quelph Univ. (Ontario). Dept. of Environmental

For primary bibliographic entry see Field 5C. W91-11456

SAPROBIOLOGICAL INVESTIGATIONS ON THE BOTTOM FLORA OF THE RIVER RECK-NITZ IN THE NORTHERN PART OF THE MECKLENBURGIAN LAKE DISTRICT (GDR)
(SAPROBIOLOGISCHE UNTERSUCHUNGEN
AN DER BENTHOSFLORA DER RECKNITZ
IM NORDEN DER MECKLENBURGER SEEN-PLATTE (DDR)), Rostock Univ. (German D.R.). Dept. of Biology.

Limnologica LMNOA8, Vol. 21, No. 1, p 237-241, October 1990. 3 fig, 19 ref. English summary.

Descriptors: \*Benthic flora, \*Recknitz River, \*Stream biota, \*Water pollution effects, \*Water quality, Bioindicators, Germany, Species composition, Statistical analysis, Water quality monitoring.

Between August 1985 and May 1986 the bottom flora of the Recknitz River a highly polluted low-land river in the northern part of East Germany, was investigated saprobiologically. The saprobic index was calculated based on a list of species, and a statistical survey of the deviation from the arithmetic mean was made. The saprobic indices showed that conditions in the river ranged from beta-mesaprobic to polysaprobic. It was found that the calculated index may differ from the real value by a factor of 1/3 to 1/2. Investigations of microflora correlated very well with those of macroflora, indicating that the use of autotrophic organisms for the determination of water quality up to the polysaprobic level is possible. Valid results can be expected up to an alpha-mesoprobic level. (Author's abstract) thor's abstract)

MICROZOOBENTHOS OF THE RIVER JIH-LAVA AFTER THE CONSTRUCTION OF THE DALESICE WATERWORKS.

Brno Univ. (Czechoslovakia). Dept. of Biology. For primary bibliographic entry see Field 6G. W91-11521

IDENTITY OF SUSPENDED PARTICLES IN A CALCITE-DEPOSITING STREAM AND THEIR SIGNIFICANCE IN TRAPPING AND BINDING PHENOMENA.

#### Streamflow and Runoff-Group 2E

King's Coll., London (England). Div. of Biosphere

A. Pentecost. Limnologica LMNOA8, Vol. 21, No. 1, p 251-255, October 1990. 4 fig, 2 tab, 14 ref.

Descriptors: \*Algae, \*Calcite, \*Dissolved solids, \*Streams, \*Suspended solids, \*Trapping, Aluminum, Calcium, Cyanophyta, Diatoms, England, Environmental chemistry, Geochemistry, Iron, Magnesium, Mineralization, Mineralogy, Nucleation, Organic matter, Potassium, Quartz, Silicon, Sodium, Supersaturation, X-ray diffraction, X-ray spectroscopy.

A study was undertaken to estimate the significance of the trapping and binding of suspended particles in a stream containing stromatolite-forming cyanophyta. The investigation was conducted at three sites in Waterfall Beck, North Yorkshire, England. The suspended load of the stream was determined over a one-year period and the x-ray spectra of 960 particles were analyzed. Particles were classified into six groups according to their x-ray spectra: (1) calcium only; (2) silicon only; (3) strong Al and Si plus weaker signals for any combination of Ca, Fe, K, Na, and Mg; (4) no peaks; (5) silicon peak with diatom frustule; and (6) a small residuum of diverse particles often rich in iron. The first five series of spectra represent respectively, calcite (24.5%), quartz (17.6%), aluminosilicate minerals (28.9%), organic matter (19.6%), and diatoms (3.5%). The presence of calcite and quartz was confirmed by x-ray diffraction, but no clear signals were obtained from the aluminosilicates, suggesting considerable mineralogical heterogeneity in this group. The trapping and binding of CaCO3 particles by microorganisms was shown to be negligible, with >85% of the calcite precipitated in situ. Nucleation of calcite in supersaturated water was considered to be unlikely. Results emphasized the importance of dissolved load, as compared to suspended load in limestone streams; suspended loss is about 0.1% of the dissolved loss. (Doria-PTT) pended loss (Doria-PTT) W91-11522

RISE AND FALL OF THE POTOMAC RIVER STRIPED BASS STOCK: A HYPOTHESIS OF THE ROLE OF SEWAGE.

Maryland Univ., Solomons. Chesapeake Biological

For primary bibliographic entry see Field 5C.

HABITAT USE BY AN ASSEMBLAGE OF FISH IN A LARGE WARMWATER STREAM.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences. For primary bibliographic entry see Field 2H. W91-11533

DISTRIBUTION, HABITAT USE, AND GROWTH OF AGE-0 COLORADO SQUAW-FISH IN THE GREEN RIVER BASIN, COLO-RADO AND UTAH.

Fish and Wildlife Service, Vernal, UT. For primary bibliographic entry see Field 2H. W91-11534

UPSTREAM EXTIRPATION OF FOUR MINNOW SPECIES DUE TO DAMMING OF A PRAIRIE STREAM.

Oklahoma Univ., Norman. Dept. of Zoology. For primary bibliographic entry see Field 6G. W91-11535

SEDIMENT DENITRIFICATION POTENTIAL IN THE ELIZABETH RIVER, VIRGINIA.
Old Dominion Univ., Norfolk, VA. Dept. of Biological Sciences

For primary bibliographic entry see Field 5C. W91-11537

ESTIMATING FLOW CHARACTERISTICS AT UNGAUGED SITES.

#### Group 2E-Streamflow and Runoff

Geological Survey, Reston, VA.
H. C. Riggs.
IN: Regionalization in Hydrology. Proceedings of
the Ljubljana Symposium, April 1990. IAHS Publication No. 191, 1990. p 159-169, 3 fig. 2 tab, 14

Descriptors: \*Stream gaging. \*Streamflow fore-casting. \*Data interpretation, \*Streamflow, \*Model studies, \*Flow characteristics, Interpola-tion, Mathematical analysis, Drainage area, Slope, Precipitation, Peak flow, Regression analysis.

Given a network of gaging stations and data on the climatic and physical characteristics of drainage basins in the region, one can relate flow characteristics to basin characteristics and use the relation to estimate flow characteristics at ungaged sites. The commonly used log linear model produces a relation that is homoscedastic—that is, the standard error is the same throughout the ranges of the independent variables. A problem in applying the log linear model arises when the value of a variable for some basis is zero, for which there is no real logarithm. This can be overcome by adding a small constant to all the values of that particular variable before using the variable in regression. Many basis and climatic characteristics have been proposed and used, and in the desire to attain the smallest standard error of regression, the analyst may pu many characteristics in a regression and use all those that are found to be statistically significant. Drainage area, channel slope, storm precipitation for some duration and recurrence interval, and surface storage are known to affect flood peak characteristics. For mean flow, the principal characteristics are drainage area and annual precipitation. If a basin characteristic, such as channel ston. It a basic characteristic, such as channel slope, has nearly the same value for all streams in a region, its regression coefficient would not be statistically significant and slope should be eliminated from the regression. The reliability of a regional from the regression. The retability of a regional relation, or even its validity in a particular region, will depend on the quality of the streamflow data, the homogeneity of the region hydrologically, and the adequacy of information about the basin. Streamflow records, and thus flow characteristics, are commonly available at intervals along large streams. Better estimates between gaged sites can be made by interpolation than by other methods, particularly in semiarid regions in which not all parts of the drainage basin contribute equally or at the same time. Interpolation of flood characteristics between gaged sites on a channel is by trial, using the assumptions that appreciably increase occur only where tributaries enter. Discharge is occur only where tributaries enter. Discharge is plotted against channel length because this format allows for marking identifiable points along the channel so that a user can readily identify his point of interest. The result is most reliable where low flow characteristics of tributaries are available. (Lantz-PTT) W91-11545

SHORT-TERM EFFECTS OF A CATASTROPHIC BEAVER DAM COLLAPSE ON A STREAM FISH COMMUNITY.
North Dakota Univ., Grand Forks. Dept. of Biol-

ogy.
J. D. Stock, and I. J. Schlos

S. D. Succk, and I. J. Schlosser.
Environmental Biology of Fishes EBFID3, Vol. 31, No. 2, p 123-129, June 1991. 3 fig, 14 ref, append. NSF Grant Nos. BSR 8320371 and BSR 8804926.

Descriptors: \*Dam failure, \*Flash floods, \*Stream fisheries, \*Beaver dams, \*Benthic fauna, Riffles, Insects, Ecosystems, Species diversity, Population dynamics, Fish populations.

The catastrophic collapse of a beaver dam and the ensuing flash flood, in a headwater tributary of the Mississippi River, resulted in a dramatic (> 90%) ensuing hash floods, in a fleaturater tribitary of the Mississippi River, resulted in a dramatic (> 90%) decrease in benthic insect density in riffle and pool habitats. Sixty days after collapse of the dam, insect densities in riffles were 62% of pre-collapse densities. Insect recolonization of pools was slower than for riffles; 60 days after collapse of the dam insect densities in pools were 8% of pre-collapse levels. Collapse of the beaver dam altered the structure of the downstream fish community by causing a short-term (2-4 days) influx of pond

species, resulting in a brief increase in species richness and abundance. Fish species richness and abundance then decreased for 4-60 days to levels below those prior to the collapse. (Author's ab-

DRIFT OF THE CHARACIN LARVAE, BRY-CONAMERICUS DEUTERODONOIDES, DURING THE DRY SEASON FROM ANDEAN PIEDMONT STREAMS.

Maryland Univ., College Park. Dept. of Zoology. For primary bibliographic entry see Field 2H. W91-11560

DESCRIPTION OF THE PHYSICAL ENVI-RONMENT AND COAL-MINING HISTORY OF WEST-CENTRAL INDIANA, WITH EMPHASIS ON SIX SMALL WATERSHEDS.

J. D. Martin, C. G. Crawford, R. F. Duwelius, and

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2368, 1990. 38p, 24 fig, 10 tab. 40 ref.

Descriptors: \*Coal mining, \*Geohydrology, \*Groundwater pollution, \*Groundwater quality, \*Water pollution sources, Agriculture, Aquifers, Eel River Basin, History, Pond Creek, Rainfallrunoff relationships, Soil types, Wabash River Basin, White River Basin.

West-central Indiana is underlain by coal-bearing Pennsylvanian rocks. Nearly all of the area has been glaciated at least once and is characterized by wide flood plains and broad, flat uplands. Most of the soils have formed in loess or in loess overlying Illinoian till. The Wabash, White, and Eel Rivers are the major drainages in west-central Indiana. Average annual precipitation is about 13 n/5 inches/y, and average annual runoff is about 13 n/5. The most productive aquifers are confined or unconfined outwash aquifers located along the major rivers. Bedrock aquifers are regionally insigificant but are the sole source of groundwater for areas that lack outwash, alluvium, or sand and gravel but are the sole source of groundwater for areas that lack outwash, alluvium, or sand and gravel lenses in till. Indiana has > 17 billion short tons of recoverable coal reserves; about 11% can be mined by surface methods. Almost half of Indiana's surface reserves are in Clay, Owen, Sullivan, and Vigo Counties. More than 50,000 acres in west-central Indiana were disturbed by surface coal mining from 1941 through 1980. The unnamed tributary to Honey Creek and the unnamed tributary to Sulfur Creek are streams that drain mined and reclaimed watersheds. Ridges of mine spoil have been graded to a gently rolling topography. Soils are well drained and consist of 6 to 12 inches of silt-loam topsoil that was stockpiled and then onis are well crained and consist of 0 to 12 incnes of silt-loam topsoil that was stockpiled and then replaced over shale and sandstone fragments of the graded mine spoil. Grasses and legumes form the vegetative cover in each watershed. Pond Creek vegetative cover in each watershed. Pond Creek and the unnamed tributary to Big Branch are streams that drain mined and unreclaimed watersheds. Approximately one-half of the Pond Creek watershed is unmined, agricultural land. Soils are very well drained shally silty loams that have formed on steeply sloping spoil banks. Both watersheds contain numerous impoundments of water and have enclosed areas that do not contribute surface runoff to streamflow. The ridges of mine poil are covered with pine trees but much of the spoil are covered with pine trees, but much of the soil surface is devoided of vegetation. (See also W89-08987) (Lantz-PTT)

DELINEATION OF FLOODING WITHIN THE OZARK NATIONAL SCENIC RIVERWAYS IN SOUTHEASTERN MISSOURI-AKERS AND ALLEY SPRING.

Geological Survey, Rolla, MO. Water Resources

Div.
T. W. Alexander.
Available from Books and Open Files Reports
Section, USGS Box 25425, Denver, CO 80225.
USGS Hydrologic Investigations Atlas HA-712-A,
1990. 3p, 15 fig, 1 tab, 11 ref.

Descriptors: \*Flooding, \*Maps, \*Missouri, \*Ozark National Scenic Riverways, Current River Basin,

Data collections, Flood frequency, Flood management, Floods, Hydrologic data collections, Surface-groundwater relations.

This is the first report in a series of US Geological Survey (USGS) Hydrologic Investigations Atlases to further supplement the National Park Service general management anad development concept plan for the Ozark National Scenic Riverways in southeastern Missouri. The Current River drainage southeastern Missouri. The Current River drainage basin is characterized by narrow, cherty dolostone ridges that break abruptly to steep side slopes of mostly narrow, wooded valleys 200 to 500 ft deep During excessive rains, the rapid surface runoff from the surrounding steep valley slopes causes frequent flash flooding. Karst features and interbasin diversions of surface water and groundwater flow are common throughout the area. The many large springs, streams with large base flows, scenic caves, and rugged uplands offer many opportunities for outdoor activities, such as camping, floating, fishing, rugged uplands offer many opportunities for outdoor activities, such as camping, floating, fishing, rugged uplands offer many opportuniing, fishing, rugged uplands offer many opportuni-ties for outdoor activities, such as camping, float-ing, fishing, and hiking, especially where public accesses and facilities are provided by the National accesses and facilities are provided by the National Park Service. The purpose of this atlas is to present 100-yr and 500-yr flood discharges and elevations, and the duration of flooding at selected heavy-use areas along the Current River and Jacks Fork. Knowledge of the complex hydrology within the study area is vital in planning future development, protecting existing facilities, and ensuring the safety of visitors. This study includes: (1) assembling available data; (2) transfer of data to hydrologically similar areas; (3) evaluating and extending these data in time; and (4) presenting the results of these evaluations for reuse in estimating potential these evaluations for reuse in estimating potential flood damages within the Ozark National Scenic Riverways. This atlas describes the study area, presents a hydrologic analysis that includes the Ozark National Scenic Riverways (sheet 1), and presents the site-specific flood analysis at Akers (sheet 2), and Alley Spring (sheet 3). (See also W91-11579) (Lantz-PTT)

DELINEATION OF FLOODING WITHIN THE OZARK NATIONAL SCENIC RIVERWAYS IN SOUTHEASTERN MISSOURI-ROUND SPRING AND POWDER MILL.

Geological Survey, Rolla, MO. Water Resources

T. W. Alexander.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Hydrologic Investigations Atlas HA-712-B, 1990. 3p, 17 fig, 1 tab, 13 ref.

Descriptors: \*Flooding, \*Maps, \*Ozark National Scenic Riverways, Current River Basin, Data col-lections, Flood frequency, Flood management, Floods, Hydrologic data collections, Missouri, Surface-groundwater relations.

This is the second report in a series of US Geological Survey (USGS) Hydrologic Investigations Atlases to further supplement the National Park Service general management anad development con-cept plan for the Ozark National Scenic Riverways in southeastern Missouri. The Current River drainin southeastern Missouri. The Current River drain-age basin is characterized by narrow, cherty dolos-tone ridges that break abruptly to steep side slopes of mostly narrow, wooded valleys 200 to 500 ft deep. During excessive rains, the rapid surface runoff from the surrounding steep valley slopes causes frequent flash flooding. Karst features and interbasin diversions of surface water and groundinterbasin diversions of surface water and ground-water flow are common throughout the area. The many large springs, streams with large base flows, scenic caves, and rugged uplands offer many op-portunities for outdoor activities, such as camping, floating, fishing, rugged uplands offer many oppor-tunities for outdoor activities, such as camping, floating, fishing, and hiking, especially where public accesses and facilities are provided by the National Park Service. The purpose of this atlas is to present 100-yr and 500-yr flood discharges and elevations, and the duration of flooding at selected elevations, and the duration of flooding at selected heavy-use areas along the Current River and Jacks Fork. Knowledge of the complex hydrology within the study area is vital in planning future

Groundwater-Group 2F

development, protecting existing facilities, and ensuring the safety of visitors. This study includes: (1) assembling available data; (2) transfer of data to (1) assembling available data; (2) transfer of data to hydrologically similar areas; (3) evaluating and extending these data in time; and (4) presenting the results of these evalvuations for ruse in estimating potential flood damages within the Ozark National Scenic Riverways. This atlas describes the study area, presents a hydrologic analysis that includes the Ozark National Scenic Riverways (sheet 1), and presents the site-specific flood analysis at Round Spring (sheet 2), and Powder Mill (sheet 3). (See also W91-11578) (Lantz-PTT)

# POINT-INFILTRATION MODEL FOR ESTI-MATING RUNOFF FROM RAINFALL ON SMALL BASINS IN SEMIARID AREAS OF

J. G. Rankl.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2366, 1990. 29p, 21 fig, 12 tab, 15 ref.

Descriptors: \*Infiltration, \*Mathematical models, \*Rainfall-runoff relationships, \*Semiarid lands, \*Wyoming, Drainage, Ephemeral streams, Runoff, Soil water, Storm runoff.

A physically based point-infiltration model was developed for computing infiltration of rainfall into soils and the resulting runoff from small basins in Wyoming. The user describes a 'design storm' in terms of average rainfall intensity and storm duration. Information required to compute runoff Wyoming. The user describes a 'design storm' in terms of average rainfall intensity and storm duration. Information required to compute runoff for the design storm by using the model include: (1) soil type and description; and (2) two infiltration parameters and a surface retention storage parameter. Parameter values are tabulated in the report. Rainfall and runoff data for three emphemeral stream basins that contain only one type of soil were used to develop the model. Two assumptions were necessary: antecedent soil moisture is some long-term average, and storm rainfall is uniform in both time and space. The infiltration and surface retention storage parameters were determined for the soil of each basin. Observed rainstorm and runoff data were used to develop a separation curve, or incipient-runoff curve, which distinguishes between runoff and nonrunoff rainfall data. The position of this curve defines the infiltration and surface retention storage parameters. A procedure for applying the model to basins that contain more than one type of soil was developed using data from 7 of the 10 study basins. Analyses of runoff from multiple-soil basins indicate that the effective contributing area of runoff is less than the drainage area of the basin. In this study, the effective drainage area. A comparison was made of the sum of the sum of the the total drainage area. A comparison was made of the sum of the simulated runoff and the sum of the the sum of the simulated runoff and the sum of the measured runoff for all available record of runoff-producing storms in the 10 study basins. The sums of the simulated runoff ranged from 12% less than to 23.4% more than the sums of the measured runoff. A measure of the standard error of estimate was computed for each data set. These values ranged from 20-70% of the mean value of the measured runoff. Rainfall-simulator infiltrometer tests were made in two small basins. The amount of water uptake measured by the test in Dugout Creek tributary basin averaged about three times greater than the amount of water uptake computed from rainfall and runoff data. Therefore, infiltrometer data were not used to determine infiltration rates for this study. (Lantz-PTT) W91-11585

#### LEVELS AT STREAMFLOW GAGING STA-TIONS. For primary bibliographic entry see Field 7B.

W91-11586

#### FATE AND TRANSPORT OF SEDIMENT-AS-SOCIATED CONTAMINANTS.

Water Science, Boulder, CO. For primary bibliographic entry see Field 5B. W91-11587

CHARACTERIZATION AND SIMULATION OF RAINFALL-RUNOFF RELATIONS FOR HEADWATER BASINS IN WESTERN KING AND SNOHOMISH COUNTIES, WASHING-TON.

Geological Survey, Tacoma, WA. Water Resources Div. For primary bibliographic entry see Field 2A. W91-11592

ANALYSIS OF ALTERNATIVE MODIFICA-TIONS FOR REDUCING BACKWATER FLOODING AT THE HONEY CREEK COAL STRIP MINE RECLAMATION SITE IN HENRY COUNTY, MISSOURI.

Geological Survey, Rolla, MO. Water Resources Div.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4068, 1990. 22p, 12 fig. 5 tab, 14 ref.

Descriptors: \*Backwater, \*Backwater floods, \*Channel improvement, \*Coal mining, \*Flood control, \*Honey Creek Basin, Channel flow, Flooding, Flow velocity, Missouri, Model studies, Runoff, Surface water.

Studies to determine the hydrologic conditions in mined and reclaimed mine areas, as well as areas of proposed mining, have become necessary with the enactment of the Surface Mining Control and Reclamation Act of 1977. Honey Creek in Henry County, Missouri, has been re-routed to flow through a series of former strip mining pits which lie within the Honey Creek coal strip mine recla-mation site. During intense or long duration rain-falls within the Honey Creek basin, surface runoff caused flooding on agricultural land near the up-stream boundary of the reclamation site. A hydro-logic and hydraulic investigation was conducted for part of the Honey Creek basin and its adjacent for part of the Honey Creek oalsn and its augment area to evaluate the strip mining related causes of backwater flooding and possible means of alleviat-ing future flooding. The calculated existing design discharge (3,050 cu ft/s (cfs)) water surface profile is compared to the expected water surface profiles. from three assumed alternative channel modifica-tions within the Honey Creek study area. Empha-sis is placed on evaluating the potential effects of each alternative to reduce water surface elevations (backwater flooding) along the upstream boundary of the Honey Creek reclamation site near an agricultural field. The alternative channel modifications used in these analyses include: (1) improvement of channel bottom slope; (2) relocation of ment of channel bottom slope; (2) relocation of spoil material; and (3) improved by-pass channel flow conditions. Study results indicate a 0.39, 0.43, and 0.30 foot backwater reduction at the agricultural field based on the assumed channel modifications of alternatives 1, 2, and 3. Several combinations of these alternatives were analyzed, and in each case the reduction in backwater flooding was numerically equal to the sum of their individual decreases. The concurrent water surface elevation of reduction (1.12 ft) of alternative 1 (design discharge increase of 400 cns), alternative 2 (design discharge increase of 400 cns). of reduction (1.12 ft) of alternative 1 (design discharge increase of 400 cps), alternative 2 (design discharge increase of 600 cps), and alternative 3 (design discharge increase of 250 cps) can be converted into a Honey Creek design discharge increase from 3,050 cps to 4,300 cps. Thus, the alternative 1, 2, and 3 design discharge increase will reduce the agriculturarl field current (1990) frequency of backwater flooding from a 3-yr to a 6.5-yr event. (Author's abstract) W91-11595

#### GROUND-WATER FLOW AND STREAM-AQ-UIFER RELATIONS IN THE NORTHERN COASTAL PLAIN OF GEORGIA AND ADJA-CENT PARTS OF ALABAMA AND SOUTH CAROLINA.

Geological Survey, Atlanta, GA. Water Resources

For primary bibliographic entry see Field 2F. W91-11598

#### 2F. Groundwater

GROUND WATER: HOW CONTAMINATED. For primary bibliographic entry see Field 5G. W91-10484

AQUIFER RESTORATION: WHICH METHOD. For primary bibliographic entry see Field 5G. W91-10486

#### APPLICATION OF MICROBIAL TRACERS IN GROUNDWATER STUDIES.

Karlsruhe Univ. (Germany, F.R.). Lehrstuhl fuer Angewandte Geologie. For primary bibliographic entry see Field 5B. W91-10671

BEHAVIOUR OF PATHOGENIC BACTERIA, PHAGES AND VIRUSES IN GROUNDWATER DURING TRANSPORT AND ADSORPTION, Tuebingen Univ. (Germany, F.R.). Hygiene Inst. For primary bibliographic entry see Field 5B. W91-10672

## FIELD EXPERIMENTS WITH MICROBIOLO-GICAL TRACERS IN A PORE AQUIFER.

Tuebingen Univ. (Germany, F.R.). Hygiene For primary bibliographic entry see Field 5B. W91-10673

#### TRANSPORT OF MICROORGANISMS IN THE UNDERGROUND: PROCESSES, EXPERIMENTS AND SIMULATION MODELS. Stuttgart Univ. (Germany, F.R.). Inst. fuer Was-

For primary bibliographic entry see Field 5B. W91-10674

# SPECIES AND GENERA OF ENTEROBACTER-IACEAE IN RIVER NECKAR AND AFTER RIVER BANK FILTRATION AND THEIR RE-SISTANCE PATTERNS TO ANTIBIOTICS AND HEAVY METAL SALTS.

Universitaet des Saarlandes, Saarbruecken (Germany, F.R.). Zentrum fuer Umweltforschung, Angewandte Mikrobiologie und Hygiene. For primary bibliographic entry see Field 5B.

#### SUPERFUND RECORD OF DECISION: COM-MENCEMENT BAY/S, TACOMA, WA.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. For primary bibliographic entry see Field SG. W91-10711

#### SUPERFUND RECORD OF DECISION: IBM (SAN JOSE), CA.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. For primary bibliographic entry see Field 5G. W91-10715

#### SUPERFUND RECORD OF DECISION: DELA-WARE SAND AND GRAVEL, DE.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. For primary bibliographic entry see Field 5G. W91-10717

SUPERFUND RECORD OF DECISION: IRON HORSE PARK, MA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. For primary bibliographic entry see Field 5G. W91-10719

INSTALLATION OF THE WESTBAY MULTI-PORT GROUND-WATER SAMPLING SYSTEM

#### Group 2F-Groundwater

IN WELL 699-43-42K NEAR THE 216-B-3 POND.

Battelle Pacific Northwest Labs., Richland, WA. For primary bibliographic entry see Field 7B. W91-10720

FISCAL YEAR 1988 SUPPORTED LIQUID MEMBRANE DEVELOPMENT REPORT. Westinghouse Hanford Co., Richland, WA.
For primary bibliographic entry see Field 5G.
W91-10727

REMEDIAL INVESTIGATION OF THE HIGH EXPLOSIVES BURN PIT FACILITY, BUILD-ING 829 COMPLEX, LAWRENCE LIVER-MORE NATIONAL LABORATORY SITE 300. Lawrence Livermore National Lab., CA. Environ-mental Restoration Div. For primary bibliographic entry see Field 5B. W91-10731

STATUS OF GROUND WATER IN THE 1100

AREA. Westinghouse Hanford Co., Richland, WA For primary bibliographic entry see Field 5B. W91-10732

ESTABLISHMENT OF A GROUNDWATER RESEARCH DATA CENTER FOR VALIDATION OF SUBSURFACE FLOW AND TRANSPORT MODELS

Butler Univ., Indianapolis, IN. Holcomb Research Inst.

Inst.
P. K. M. Van der Heijde, W. I. M. Elderhorst, R.
A. Miller, and M. F. Trehan.
Available from the National Technical Information
Service, Springfield, VA. 22161, as PB89-224455.
Price codes: Al1 in paper copy, A01 in microfiche.
Report No. EPA/600/2-89/040, July 1989. 277p,
13 fig. 17 tab, 182 ref, 3 append. EPA Contract
CR-813191.

Descriptors: \*Groundwater movement, \*Informa-tion systems, \*Libraries, \*Model studies, Data in-terpretation, Data storage and retrieval, Ground-water pollution, Hydrologic data collections, In-formation exchange, Organizations, Soil water.

The International Ground Water Modeling Center (GWMC) has established a Groundwater Research (GWMC) has established a Groundwater Research Data Center which provides information on research datasets resulting from publicly funded field experiments regarding soil and groundwater pollution and related laboratory bench studies, and which distributes selected public domain datasets for testing and validation of models for flow and conteminant transport in the saturated and unsature. contaminant transport in the saturated and unsatu-rated zones of the underground. To fulfill its advisory role, the Data Center analyzes information and documentation resulting from field and labora-tory experiments, and evaluates the appropriate datasets for their suitability in model testing and validation. (The Center has identified validation as the major secondary use of such data). To assure consistency in the analysis and description of these datasets, and to provide an efficient way to search, retrieve, and report information on these datasets, the Data Center has developed a computerized data directory, SATURN, programmed independently from any proprietary software. As secondary users of such soil water and groundwater data are highly interested in information relevant to the assessment of data quality, a primary concern of the Center is the evaluation and documentation of the level of quality assurance applied during data acquisition, data handling, and data storage. In addition to providing referral services, the Data Center distributes, on an 'as-is' basis, selected, high quality datasets described in the data directory. The datasets of concern represent different hydrological, geological, and geographic-climatic set-tings, pollutant compositions, and degrees of con-tamination. (Lantz-PTT) W91-10736

SOIL VAPOR SURVEY AT THE LLNL SITE 300 GENERAL SERVICES AREA, ADJACENT PORTIONS OF THE CONNOLLY AND GALLO RANCHES AND THE SITE 300 LANDFILL PIT 6 AREA.

Weiss Associates, Oakland, CA. For primary bibliographic entry see Field 5B. W91-10747

EFFECTS OF LAND-USE BUFFER SIZE ON SPEARMAN'S PARTIAL CORRELATIONS OF LAND USE AND SHALLOW GROUND-WATER

Geological Survey, Trenton, NJ. For primary bibliographic entry see Field 4C.

PRECONDITIONED CONJUGATE-GRADIENT 2 (PCG2), A COMPUTER PROGRAM FOR SOLVING GROUND-WATER FLOW EOUA-

Geological Survey, Denver, CO. For primary bibliographic entry see Field 7C. W91-10764

GEOHYDROLOGIC EVALUATION SPRING SITES AT SOCIAL CIRCLE, GEOR-GIA, DECEMBER 5-8, 1988.

Geological Survey, Doraville, GA

I S Clarke

Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Feder-al Center, Denver, Co 80225-0425. Open-File Report 89-236, 1989. 18p. 7 fig. 1 tab, 13 ref.

Descriptors: \*Drawdown, \*Geohydrology, \*Georgia, \*Groundwater management, \*Groundwater yield, \*Springs, \*Water yield, Aquifers, Catchment areas, Groundwater recharge, Groundwater resources, Pumping, Recharge.

Two springs in the Piedmont physiographic province at Social Circle, Georgia, were evaluated to determine their geohydrologic characteristics, estimated recharge, and maximum sustained yield. Aquifer tests indicated that the springs respond to pumping in a manner similar to bored wells in the Piedmont. At the lower spring, a pronounced water level response to rainfall indicates that it is under water table conditions. Recharge to the water table is believed to be limited to a 0.18 sq mi under water table conditions. Recnarge to me water table is believed to be limited to a 0.18 sq mi under water table conditions. Recharge to the water table is believed to be limited to a 0.18 sq mi drainage basin upgradient of the lower spring. The small drainage area and an estimated annual recharge rate of 6.5 inches indicates that the potential yield to the springs averages about 55,690 gallons per day (gpd). The 13-foot deep lower spring was the most productive, sustaining yields of between 60 and 94 gpm during much of a 25-hour aquifer test. Sluggish recovery during the last 11% of drawdown may indicate: (1) a water level decline due to below normal rainfall, (2) that pumping from the upper spring intercepted recharge to the lower spring, or (3) that some water was removed from groundwater storage during the aquifer tests. The 21-foot deep upper spring was pumped at rates ranging from 34 to 83 gpm, and was able to sustain yields of 34 to 40 gpm during a 25-hour aquifer test. At a rate of 34 gpm, drawdown in the spring reservoir stabilized at about 62% of the available drawdown, which was probably close to the maximum sustained yield. Although results of the two tests indicate that the combined yield of the two tests indicate that the combined yield of the two tests indicate that the though results of the two tests indicate that the combined yield of the two springs ranged from about 135,360 to 184,320 gpd in December 1988, it is doubtful that a combined pumping rate in excess of the estimated average potential yield of the drainage basin (55,690 gpd) could be maintained on a natural basis. As intermittent pumping schedula an annual basis. An intermittent pumping schedule allows for pumping at a higher rate at peak demand periods and at lower rates during periods of low demand. (Author's abstract)

GROUND-WATER FLOW AND SOLUTE MOVEMENT TO DRAIN LATERALS, WESTERN SAN JOAQUIN VALLEY, CALIFORNIA. I. GEOCHEMICAL ASSESSMENT.

Geological Survey, Sacramento, CA For primary bibliographic entry see Field 5B. GROUND-WATER FLOW AND SOLUTE MOVEMENT TO DRAIN LATERALS, WEST-ERN SAN JOAQUIN VALLEY, CALIFORNIA. II. QUANTITATIVE HYDROLOGIC ASSESS-

Geological Survey, Sacramento, CA. For primary bibliographic entry see Field 5B. W91-10769

CHARACTER AND EVOLUTION OF THE GROUND-WATER FLOW SYSTEM IN THE CENTRAL PART OF THE WESTERN SAN JOAQUIN VALLEY, CALIFORNIA.

K. Belitz, and F. J. Heimes. Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Feder-al Center, Denver, Co 80225-0425. Water-Supply Paper 2348, 1990. 28p, 24 fig, 31 ref.

Descriptors: \*Geohydrology, \*Groundwater movement, \*Groundwater resources, \*San Joaquin Valley, Agriculture, Aquifers, Confined aquifers, Flow pattern, Groundwater irrigation, Groundwater mining, Groundwater quality, Groundwater recharge, Percolation, Potentiometric surface, Water use.

The occurrence of selenium in agricultural drain water derived from the western San Joaquin Valley, California, has focused concern on the groundwater flow system of the western valley. Previous work, and recently collected texture and Previous work, and recently collected texture and water level data, are used to evaluate the character and evolution of the regional groundwater flow system in the central part of the western valley. Particular emphasis is placed on the deposits overlying the Corcoran Clay Member of the Tulare Formation, which presently divides the flow system into an upper semiconfined zone and a lower confined zone. Above the Corcoran, three hydrogeologic units can be recognized: Coat Ranges alluvium, Sierran sand, and flood-basin deposits. These units differ in texture, hydrologic properties, and oxidation state. The development of irrigated agriculture in the central part of the western valley has significantly altered the flow system. Percolation of irrigation water past crop roots has caused a rise in the altitude of the water table in midfan and distal-fan areas. Pumpage of table in midfan and distal-fan areas. Pumpage of groundwater from wells has caused a lowering of he water table beneath parts of the fanheads and a the water table beneath parts of the fanheads and a lowering of the potentiometric surface of the confined zone over much of the western valley. The combination of percolation and pumpage has resulted in the development of a large downward hydraulic head gradient in the semiconfined zone and has created a groundwater divide. Surface water deliveries from the California Aqueduct have allowed a decrease in numning and a consehave allowed a decrease in pumping and a conse-quent recovery in hydraulic head throughout the system. (Author's abstract) W91-10772

EVIDENCE FOR DILUTION OF DEEP, CON-FINED GROUND WATER BY VERTICAL RE-CHARGE OF ISOTOPICALLY HEAVY PLEIS-TOCENE WATER.
Syracuse Univ., NY. Dept. of Geology.

D. I. Siegel.

Geology GLGYBA, Vol. 19, No. 5, p 433-436, May 1991. 2 fig, 3 tab, 22 ref.

Descriptors: \*Groundwater recharge, \*Iowa, \*Pa-leohydrology, \*Radioactive dating, Aquifers, Carbon radioisotopes, Chemical analysis, Darcys law, Geohydrology, Mixing, Oxygen radioiso-topes, Precipitation, Snowmelt.

New analyses of the isotopic composition of water, 14C-dating of dissolved carbon, and order-of-mag-nitude Darcy calculations suggest that a dilute nitude Darcy calculations suggest that a dilute body of water, trending north-south in the Cambri-an-Ordovician aquifer of Iowa, was emplaced as vertical recharge of Pleistocene-age water from the base of the Des Moines lobe of late Wisconsin time. The recharge occurred through more than 300 m of overlying Silurian to Mississippian age rocks. The delta 180 values range from -10 ppt to -90 ppt for the dilute water body and are consistent with a mixture of Des Moines lobe meltwater and

#### Groundwater-Group 2F

precipitation having an isotopic content similar to or heavier than that of average precipitation found today in the north-central United States. These results suggest that (1) the climate at the end of last glaciation was mild, and (2) a groundwater stable isotope signature similar to that of modern precipitation in an aquifer's recharge area is not a priori evidence for relatively recent recharge. (Author's abstract) abstract)

IMPACT OF RECHARGE THROUGH RESIDU-AL OIL UPON SAMPLING OF UNDERLYING GROUND WATER.

Auburn Univ., AL. Dept. of Civil Engineering. For primary bibliographic entry see Field 5B.

CONE PENETROMETER TESTS AND HY-DROPUNCH SAMPLING: A SCREENING TECHNIQUE FOR PLUME DEFINITION. EMCON Associates, San Jose, CA. For primary bibliographic entry see Field 5A. W91-10794

MUNICIPAL GROUND WATER FROM ANCIENT CRYSTALLINE BEDROCK. Caswell, Eichler and Hill, Inc., West Topsham, B. Caswell.

Water Well Journal WWJOA9, Vol. 45, No. 5, p 44-48, May 1991. 5 fig.

Descriptors: \*Crystalline rocks, \*Geohydrology, \*Geologic fractures, \*Groundwater resources, Descriptors: "Crystalline rocks, "Geohydrology, "Geologic fractures, "Groundwater resources, "Municipal water, "Water resources development, "Water supply development, Bedrock, Explora-tion, Geological surveys, Groundwater availabil-ity, Groundwater recharge, Pumping tests, Well construction."

Hydrogeologists generally do not consider the crystalline rock types of the Adirondack Mountain area of New York as a significant groundwater area of New York as a significant groundwater resource because groundwater is available only from fractures in the bedrock. A case study was undertaken in the Adirondack Mountains of New York where a municipal groundwater supply was sought to replace a lake source that could not meet federal drinking water standards without costly treatment. Groundwater exploration identified apparent bedrock fracture zones through interpretation of topographic maps, satellite imagery, and geophysics. The results of the study revealed that ancient crystalline bedrock, where well fractured, can furnish significant supplies of high-quality groundwater. The key seems to be the location of transmissive fractures where a high-yield well can be constructed, and siting wells in hydrogeologic settings that afford ample recharge in underlying bedrock fracture systems. However, similarly favorable recharge conditions may not be available everywhere in the ancient crystalline bedrock ternain of North America. Furthermore, there are too rain of North America. Furthermore, there are too few high-yield wells in the Adirondack Mountains to verify that topographic lineaments everywhere reveal water-bearing bedrock fractures. It should also be noted that the same lineaments may repreasso be lotted that the same intendences may represent highly preferential pathways for contaminant migration in crystalline bedrock terrain. (Korn-PTT)
W91-10822

DISPERSAL DYNAMICS OF GROUNDWATER

Lund Univ. (Sweden). Dept. of Ecological Chemistry. For primary bibliographic entry see Field 5B. W91-10843

CHARACTERIZATION OF RADIOACTIVITY IN HOT SPRINGS NATIONAL PARK, ARKAN-

SAS,
Arkansas Univ. for Medical Sciences, Little R
Coll. of Pharmacy.
For primary bibliographic entry see Field 2K.
W91-10846 s Univ. for Medical Sciences, Little Rock. RHINE RIFT VALLEY GROUNDWATER-RIVER INTERACTIONS: EVOLUTION OF THEIR SUSCEPTIBILITY TO POLLUTION Laboratoire de Botanique et Cryptogamie, URA 95 CNRS, Centre d'Etudes et de Reserche Biogra-phiques, PIREN Eau Alsace, Faculte de Pharma-cie BP 24, 67401 Illkirch, France. For primary bibliographic entry see Field 5B. W91-10849

GROUNDWATER FLOW AND THE METAL CONTENT OF PEAT.

Syracuse Univ., NY. Dept. of Geology. B. M. Hill, and D. I. Siegel. Journal of Hydrology JHYDA7, Vol. 123, No. 3/ 4, p 211-224, March 1991. 10 fig, 32 ref.

Descriptors: \*Geochemistry, \*Groundwater move-ment, \*Metals, \*Peat, \*Water chemistry, \*Wet-lands, Chemical composition, Hydrologic data, Ions, Permeability, Soil analysis, Soil profiles, Sub-surface water, Variability.

A study was conducted on three peat profiles from the Lost River Peatland, Minnesota, to test the extent to which the metal content of peat is modified by active groundwater flow and the extent to which it can be used to locate groundwater discharge. It was found that major variations in the concentrations of the base cations Ca, Mg, Sr, and the minor metals Fe and Na in peat profiles from the Lost River Peatland are mostly related to the the Lost River Peatland are mostly related to the geochemical environment caused by groundwater discharge into the peat, rather than to differences in anthropogenic atmospheric loadings or the original chemical composition of the peat at the time of deposition. Elevated concentrations of metals in the peat profile, particularly from a spring-fen, identify where the greatest volume of groundwater discharge occurs in the peatland. In each profile, the metal content of the peat corroborates previous hydrologic and geochemical studies each profile, the metal content of the peat corroso-rates previous hydrologic and geochemical studies showing active groundwater flow in the humified peat, which must have substantial permeability. Consequently, metal profiles in peat may be used as indicators of the conditions of groundwater flow in peatlands where other hydrologic or geochemi-cal information is lacking. (Agostine-PTT) W91-10902

HYDROGEOCHEMICAL PROCESSES CONTROLLING SUBSURFACE TRANSPORT FROM AN UPPER SUBCATCHMENT OF WALKER BRANCH WATERSHED DURING STORM EVENTS. 1. HYDROLOGIC TRANSPORT PROCESSES.

Tennessee Univ., Knoxville. Dept. of Plant and Soil Science. For primary bibliographic entry see Field 5B. W91-10907

HYDROGEOCHEMICAL PROCESSES CON-TROLLING SUBSURFACE TRANSPORT FROM AN UPPER SUBCATCHMENT OF WALKER BRANCH WATERSHED DURING STORM EVENTS. 2. SOLUTE TRANSPORT PROCESSES

Tennessee Univ., Knoxville. Dept. of Plant and Soil Science For primary bibliographic entry see Field 5B. W91-10908

NITRATE REMOVAL BY DENITRIFICATION IN ALLUVIAL GROUND WATER: ROLE OF A

FORMER CHANNEL.
Centre National de la Recherche Scientifique,
Toulouse (France). Centre d'Écologie des Ressources Renouvelables. For primary bibliographic entry see Field 5B. W91-10909

COMPUTATION OF AVERAGE SEASONAL GROUNDWATER FLOWS IN PHREATIC AQUIFER-RIVER SYSTEM.

Indian Inst. of Tech., Bombay. Dept. of Civil Engineering. A. K. Rastogi.

Journal of Hydrology JHYDA7, Vol. 123, No. 3/

4, p 355-365, March 1991. 4 fig, 2 tab, 11 ref.

Descriptors: \*Aquifers, \*Groundwater movement, Groundwater recharge, "Mathematical studies, "Monsoons, "Rivers, "Seasonal variation, "Surface-groundwater relations, "Water table aquifers, Finite difference methods, Fluctuations, Reser-

A simplified approach to reduce a time-variant problem into a steady-state problem is considered by averaging the groundwater head over a season-al period. This averaging is applicable to those areas (countries) where a year can be divided into three distinct periods; monsoon, pre-monsoon, and post monsoon; and where the annual water table post monsoon; and where the annual water table variation is not large compared with the saturated aquifer thickness. This scheme was applied to solve a two-dimensional problem using a standard finite difference technique of solution. The phreatic aquifer system considered is bounded by two reservoirs and an impervious base. It also contains a partially protected the souther of t penetrating river near the center of the aquifer. penetrating river near the center of the adjunc-periodic contribution to the phreatic aquifer from the higher head reservoir, groundwater recharge from river seepage, net-free surface flux and the total groundwater flow towards the lower head reservoir are worked out were determined. The analysis of the flow curves reveals that the lowering in the total flow values from monsoon to post-monsoon and pre-monsoon is caused primarily by a decrease in the net-free surface flux values, seconddecrease in the net-tree surrace hux values, second-ly by a reduction in the flow contributions from the higher head reservoir and finally and of least significance, by the river contributions which show a minimum variation with seasonal changes show a minimum variation with seasonal changes in weather. The study shows that on a yearly basis 64.6% of the total available groundwater is contibuted by effective annual free surface flux and 29.2% by the higher head reservoir, while only 6.2% is added from river seepage. These terms aid in estimating the net volume of groundwater that is available from the aquifer system in a particular seasonal period. (Agostine-PTT) W91-10910

RIPARIAN ZONE AS A SOURCE OF PHOS-PHORUS FOR A GROUNDWATER-DOMINAT-

Lund Univ. (Sweden). Dept. of Ecology. For primary bibliographic entry see Field 2H. W91-10931

PROSPECTING FOR ZONES OF CONTAMINATED GROUND-WATER DISCHARGE TO STREAMS USING BOTTOM-SEDIMENT GAS

Geological Survey, Columbia, SC. Water Resources Div.

For primary bibliographic entry see Field 5B. W91-10951

GEOCHEMICAL EVOLUTION IN THE CAM-BRIAN-ORDOVICIAN SANDSTONE AQUI-FER, EASTERN WISCONSIN: 1. MAJOR ION AND RADIONUCLIDE DISTRIBUTION. Wisconsin Univ.-Madison. Dept. of Geology and Geochwischen

Geophysics. For primary bibliographic entry see Field 2K. W91-10953

EMBEDDING AND RESPONSE MATRIX TECHNIQUES FOR MAXIMIZING STEADY-STATE GROUND-WATER EXTRACTION; COMPUTATIONAL COMPARISON.

Utah State Univ., Logan. Dept. of Agricultural and Irrigation Engineering. R. C. Peralta, H. Azarmnia, and S. Takahashi. Ground Water GRWAAP, Vol. 29, No. 3, p 357-364, May/June 1991. 2 fig, 2 tab, 43 ref.

Descriptors: \*Computer models, \*Confined aquifers, \*Geochemistry, \*Groundwater management, \*Groundwater movement, \*Radioisotopes, \*Sustained yield, \*Well yield, Embedding techniques, Mathematical studies, Matrix techniques, Numerical analysis, Optimization, Pumping.

#### Group 2F-Groundwater

Both response matrix and embedding techniques are commonly used to compute optimal sustained-yield groundwater extraction strategies for con-fined aquifers. Historically, the response matrix method has been considered the most practical, because of numerical instability reported to occur when using the explaciding expressions. because of numerical instability reported to occur when using the embedding approach for large aquifer systems. More recent studies have proven the embedding approach to be stable for large-scale regional planning. Also, there is increasing emphasis on using microcomputers for groundwater studies. Thus, it is appropriate to compare response matrix and embedding approaches to steady-state problems in terms of computational efficiency and memory requirements. For the hypothetical study area, a steady-state embedding model requires less area, a steady-state embedding model requires less processing time than a comparable response matrix model. In addition, the embedding model sometimes requires less memory than a response matrix model. Required computer memory is frequently a function of the number of nonzero values in con-straint equations. For embedding models, the number of nonzeroes is fixed for a particular study area. For response matrix models, the number of area. For response matrix modes, the number of nonzeroes can increase dramatically in proportion to the number of pumping cells and cells at which heads must be constrained. For the sample system, if more than 25% of the cells can pump, the If more than 25% of the cells can pump, the response matrix approach requires more memory than does the embedding approach. Before selecting an optimization model for a particular study, one should, evaluate potential memory requirements of both embedding and response matrix approaches. If there is a high percentage of pumping cells, or if many heads must be constrained or computed within the confinitestion model the or computed within the optimization model, the em-bedding approach seems preferable. (Author's abstract) W91-10954

APPLICATION OF GROUND-PENETRATING-RADAR METHODS IN HYDROGEOLOGIC STUDIES.

Geological Survey, Hartford, CT. Water Resources Div.

For primary bibliographic entry see Field 7B. W91-10956

DELINEATION OF TRAVELTIME-RELATED CAPTURE AREAS OF WELLS USING ANA-LYTICAL FLOW MODELS AND PARTICLE-TRACKING ANALYSIS.

Ohio State Univ., Columbus. Dept. of Geology

and Mineralogy. E. S. Bair, A. E. Springer, and G. S. Roadcap. Ground Water GRWAAP, Vol. 29, No. 3, p 387-397, May/June 1991. 17 fig. 13 ref.

Descriptors: \*Aquifer properties, \*Flow models, \*Groundwater movement, \*Model studies, \*Pumping tests, \*Well hydraulics, Flow measurement, Geohydrology, Traveltime, Well data, Well fields, Well pumping.

Traveltime-related capture areas of wells can be estimated in hydrogeologic settings with predominantly two-dimensional flow regimes using image-well theory, the principle of superposition, an appropriate well-hydraulics equation, and particle-tracking analysis. These analytical methods can be used to simulate the response of an aquifer to pumping stress by incorporating site-specific values of hydraulic properties, the effects of geologic and hydrologic boundaries, nonuniform regional hydraulic gradients, and well interferences. This is done by developing a conceptual model of the flow system, incorporating an image-well solution (if needed), computing drawdowns at the intersections of a rectangular grid superposed over the area of interest, and subtracting computed microcctions of a rectangular grid superposed over the area of interest, and subtracting computed drawdowns from regional prepumping head values assigned to the grid intersections. The resulting flow model can be calibrated by comparing pre-dicted heads with measured heads. The calibrated head distribution then is used in a particle-tracking analysis to determine flowpath trajectories and traveltime-related capture areas of wells. Analyti-cal flow models based on the Theis equation and the Hantush-Jacob equation were constructed from conceptual flow models based on geologic, hydrologic, and pumpage data from wellfields completed

in a confined/unconfined stratified-drift aquifer and in a leaky-confined fractured-carbonate aquifer. Predicted head distributions from the calibrat-ed flow models were used in a particle-tracking analysis to compute flowpath trajectories and trav-eltime-related capture areas. The results compare favorably with known flowpaths from sources of contamination proximal to each wellfield. (Author's abstract) W91-10957

TRITIUM AS AN INDICATOR OF GROUND-WATER AGE IN CENTRAL WISCONSIN.

Wisconsin Geological and Natural History Survey, Madison.

K. R. Bradbury. Ground Water GRWAAP, Vol. 29, No. 3, p 398-404, May/June 1991. 6 fig, 3 tab, 15 ref.

Descriptors: \*Groundwater chemistry, \*Groundwater dating, \*Tritium, \*Wisconsin, Glacial soils, Groundwater data, Groundwater movement, Groundwater recharge.

In regions where groundwater is generally younger than about 30 years, developing the tritium input history of an area for comparison with the current tritium content of groundwater allows quantitative estimates of minimum groundwater age. The tritium history for central Wisconsin has age. The tritium instory for central wisconsin has been constructed using precipitation tritium measured at Madison, Wisconsin, and elsewhere. Weighted tritium inputs to groundwater reached a peak of over 2,000 tritium units (TU) in 1964, and have declined since that time to about 20-30 TU at present. In the Buena Vista basin in central Wis-consin, most groundwater samples contained ele-vated levels of tritium, and estimated minimum groundwater ages in the basin ranged from less groundwater ages in the basin ranged from less than one year to over 33 years. Groundwater in mapped recharge areas was generally younger than groundwater in discharge areas, and estimated groundwater ages were consistent with flow system interpretations based on other data. Esti-mated minimum groundwater ages increased with mated minimum groundwater ages increased with depth in areas of downward groundwater movement. However, water recharging through thick moraine sediments was older than water in other recharge areas, reflecting slower infiltration through the sandy till of the moraine. (Author's W91-10958

DEPTH OF FRACTURES AND ACTIVE GROUND-WATER FLOW IN A CLAYEY TILL PLAIN IN SOUTHWESTERN ONTARIO. Waterloo Univ. (Ontario). Inst. for Ground Water

W. W. Ruland, J. A. Cherry, and S. Feenstra. Ground Water GRWAAP, Vol. 29, No. 3, p 405-417, May/June 1991. 9 fig, 3 tab, 27 ref.

Descriptors: \*Canada, \*Clay soils, \*Geologic fractures, \*Groundwater movement, \*Ontario, \*Tritium, Aquifer characteristics, Hydraulic conductivi-ty, Water table fluctuations.

The St. Clair Plain in southwestern Ontario is underlain by extensive clayey till deposits which are generally 30 m to 40 m thick. The tills have vertical fractures near the ground surface, and the depth of those fractures has been investigated. Observations in test pits show that most weather-Observations in test pits snow that most weather-ing features along fractures reach a depth of only 2.5 m to 4 m, though isolated major fractures extend past the pit bottom depth of 5.6 m at two sites. The depth of active groundwater flow, which is defined as the groundwater flow in the clayey deposit which occurs in fractures, was also investigated. Water such account a state shows bulk investigated. Water-level response tests show bulk hydraulic conductivities of the fractured till ranging from >0.0000001 to 0.0000001 cm/s. Seasonal variations in hydraulic head profiles suggest that fractures influence groundwater flow to maximum depths ranging from 5 m to more than 10 m at the 10 sites studied. The water table is usually within 2 To sites studied. The water table is usually within 2 m of the surface, but piezometers went dry to depths of 2 m to 4.9 m during dry periods in 1987 and 1988. Tritium levels greater than 1 tritium unit (TU), indicating the presence of post-1952 water, are found to depths of 7.5 m at all sites and to

depths exceeding 12 m in two cases. Tritium has moved to the base of deep, open fractures by active groundwater flow and has travelled 1 or 2 m beyond that depth by molecular diffusion. Observations of seasonal water-level variations and tritium sampling show the most promise for determining the maximum depth of hydraulically active, vertical fractures. The maximum depth of active consedures flow in features were widely range. groundwater flow in fractures varies widely, ranging from 5 m to more than 10 m at the 12 sites studied on the St. Clair Plain. (Author's abstract)

DELINEATION OF A DISCONTINUOUS AQUITARD WITH VERTICAL ELECTRICAL SOUNDINGS, SAN BERNARDINO VALLEY, SOUTHERN CALIFORNIA.
California Univ., Riverside. Inst. of Geophysics and Plenetery Physics.

and Planetary Physics.
For primary bibliographic entry see Field 5B.

W91-10960

METHOD TO DETERMINE THE FORMA-TION CONSTANTS OF LEAKY AQUIFERS, AND ITS APPLICATION TO PUMPING TEST DATA.

Technische Univ., Vienna (Austria). Abt. Geophysics. For primary bibliographic entry see Field 7C.

METHOD FOR INSTALLING MINIATURE MULTILEVEL SAMPLING WELLS, Wisconsin Univ.-Madison. Dept. of Soil Science. For primary bibliographic entry see Field 5A. W91-10962

CONTRIBUTION TO THE STUDY OF THE RE-CONTRIBUTION TO THE STUDY OF THE RE-CESSION CURVES OF KARSTIC SPRINGS: EXAMPLES FROM GREECE (CONTRIBU-TION A L'ETUDE DES COURSES DE RECES-SION DES SOURCES KARSTIQUES: EXEM-PLES DU PAYS HELLENIQUE).

Thessaloniki Univ., Salonika (Greece). Dept. of Geology and Physical Geography.

Journal of Hydrology JHYDA7, Vol. 124, No. 1/ 2, p 29-42, April 1991. 14 fig, 35 ref.

Descriptors: \*Aquifer systems, \*Greece, \*Karst hydrology, \*Recession curve, \*Springs, \*Surface-groundwater relations, Aquifer characteristics, Boundary conditions, Limiting factors.

A study of the recession curves of the major springs of six systems of karstic aquifers in Greece shows that each of these aquifers is unique in respect of its boundary conditions, its internal organization and its hydrodynamics, differences which result in different forms of recession curves. which result in different torns of recession curves. Three of the examples showed a wide range of quantitative differences with respect to their internal structure or degree of karstification. The other three cases showed qualitative differences: different limiting conditions which can result in slight variations. These case studies could be used to predict the recession curves of karstic springs and, hence, for the classification of aquifer systems. hence, for (Fish-PTT) W91-10990

EFFECT OF LAND DEVELOPMENT ON GROUNDWATER RECHARGE DETERMINED FROM NON-STEADY CHLORIDE PROFILES. Queensland Dept. of Primary Industries, Brisban (Australia). Soil Conservation Research Branch For primary bibliographic entry see Field 4C. W91-10991 Branch.

ENVIRONMENTAL ISOTOPE STUDY FOR ES-TIMATING LEAKAGE AND RUNOFF OF GROUND WATERS IN THE XI'AN AREA. Institute of Karst Geology, Guilin (China).

Journal of Hydrology JHYDA7, Vol. 124, No. 1/2, p 101-117, April 1991. 10 fig, 5 tab, 9 ref.

#### Groundwater—Group 2F

Descriptors: \*China, \*Confined aquifers, \*Environmental tracers, \*Groundwater movement, \*Groundwater recharge, \*Isotope studies, \*Leaky aquifers, \*Seepage, Carbon radioisotopes, Deuterium, Flow measurement, Flow models, Flow velocity, Groundwater runoff, Isotopic tracers, Oxygen isotopes. isotopes, Tritium.

A detailed study of the prediction and management of groundwater and the environment, employing new methodologies and new techniques, was started in Shaanxi Province in China in 1986, using environmental isotope techniques to trace groundwater sources, leakage among aquifers, and recharge of runoff to confined aquifers. Ninety-six water samples were collected in the Xi'an area and analyzed for D, T, 18-Q, and 14-C. Stable isotope contents of water samples from three aquifers show differences between, and mixing among, the three aquifers; the mixing ratio was 37.4% of phreatic water in the first confined aquifer and 43.8% of first mixed water to the second mixed water in the second confined aquifer. The phreatic water comprised about 43.8% x 37.4% = 16.4% of the second mixed water in the second confined aquifer. After the tritium contents in precipitation in the Xi'an regions had been reconstructed by a multiple and lighter except in the second confined aquifer. the second mace was a superstance of the Xi'an regions had been reconstructed by a multiple cell linear regression method, the ground-water velocity in the first confined aquifer was calculated as 30-39 m/yr from an exponential flow model. A 14-C piston flow model gave estimates of average flow velocity in the second confined aquifer of 1.14/yr. The runoffs in the two aquifers were calculated, but they are not the total recharge also calculated, but they are not the total recharge from the pluvial fan to the center of the cone of depression around Xi'an city; the width of re-charge must be known for this calculation. From the analyses of stable isotopes, radioisotopes, and hydrogeological conditions of thermal groundwater in front of the mountain, it seems that deep circulation is occurring from the mountain area to the second confined aquifer through an existing deep fault in front of Qing Mountain. Another possibility is that the second confined water was buried in paleoclimatic conditions and was mixed paleoclimatic conditions and was mixed with infiltrating younger surface water or mountain runoff, because of its high age and low tritium content. (Author's abstract)
W91-10994

HYDROGEOLOGIC INFERENCES FROM DRILLERS' LOGS AND FROM GRAVITY AND RESISTIVITY SURVEYS IN THE AMARGOSA DESERT, SOUTHERN NEVADA. Geological Survey, Denver, CO. For primary bibliographic entry see Field 5E. W91-10996

BOUNDARY ELEMENT AND PARTICLE TRACKING MODEL FOR ADVECTIVE TRANSPORT IN ZONED AQUIFERS.
Thesaloniki Univ., Salonika (Greece). School of

Inessatoniat Univ., Satoniaa (Greece). School of Technology. P. Latinopoulos, and K. Katsifarakis. Journal of Hydrology JHYDA7, Vol. 124, No. 1/ 2, p 159-176, April 1991. 7 fig. 25 ref.

Descriptors: \*Advection, \*Groundwater move-ment, \*Groundwater transport, \*Hydrologic models, \*Model studies, \*Path of pollutants, \*Solute transport, Boundary processes, Flow models, Flow velocity, Injection wells, Well pumping

One of the most crucial factors that affects both One of the most crucial incross that allects soon the accuracy and efficiency of a groundwater transport model is the flow simulation method which produces the velocity field. A boundary element technique has been developed which inelement technique has been developed which in-corporates the zoning approach to allow aquifer heterogeneity. First, the accuracy of the flow model is verified by comparing it with analytic solutions for well-pumping and injection problems. The boundary element flow model is then coupled with a particle tracking procedure for advection-based transport simulation. The combined model also calculates streamlines, travel times, and break-through curves and is the travel times, and breakand oreas streammes, traver times, and breast-through curves and is therefore a powerful tool for simulation and management of advection-dominat-ed contamination problems. A series of tests against analytical solutions, especially near interzonal boundaries, shows that the numerical errors produced are not significant, are explicable, and are easily controllable by simple means such as local grid refinement and use of small time steps. A realistic application of the coupled model emphasized its utility in solving real-life engineering problems. (Fish-PTT) W91-10997

DISCRETE-KERNEL METHOD FOR SIMULATING PUMPING TESTS IN LARGE-DIAMETER WELLS.

British Geological Survey, Wallingford (England). J. A. Barker.

Journal of Hydrology JHYDA7, Vol. 124, No. 1/
2, p 177-183, April 1991. 1 fig, 2 tab, 6 ref.

Descriptors: \*Hydrologic models, \*Model studies, \*Pumping tests, \*Theis equation, \*Well function, Error analysis, Well hydraulics, Well pumping.

The discrete-kernel method, as previously employed, incorrectly used the Theis well function rather than the well function for a large-diameter well without storage. Use of the Theis function and small time steps gives errors that oscillate in sign and grow exponentially with time. An approximation to this latter function, suitable for computation, has been developed so that existing codes may be readily corrected. The instability can be overcome by replacing the Theis function. be overcome by replacing the Theis function by the well function for a well of finite diameter but no storage. This replacement function ensures sta-bility for small time steps and increases the accura-cy of the method. (Fish-PTT) W91-10998

HEAVY METAL TRANSPORT TO THE GREAT LAKES BY NATURAL GROUND-WATER DIS-CHARGE: AN INITIAL EVALUATION. Syracuse Univ., NY. Dept. of Geology. For primary bibliographic entry see Field 5B. W91-11062

MAPS OF THE '400-FOOT,' '600-FOOT,' AND ADJACENT AQUIFERS AND CONFINING BEDS, BATON ROUGE AREA, LOUISIANA. Geological Survey, Baton Rouge, LA. Water Re-

Sources Div.

E. L. Kuniansky, D. C. Dial, and D. A. Trudeau.

State of Louisiana Water Resources Technical
Report No. 48, 1989. 16p, 4 fig, 1 tab, 9 plates, 29

Descriptors: \*Aquifer systems, \*Baton Rouge, \*Confined aquifers, \*Hydrologic data collections, \*Louisiana, \*Maps, Aquifers, Clays, Geohydrology, Groundwater management, Groundwater mining, Hydraulic conductivity, Model studies, Pumping, Sand.

Withdrawals of water from the '400-foot' and '600-foot' aquifers in the Baton Rouge industrial district have caused significant declines in the potentiome-tric levels. To evaluate the effect of future pump-age from the '400-foot' and '600-foot' aquifers, a digital model of these aquifers is being developed. The '400-foot,' '600-foot,' and adjacent aquifers and confining beds were mapped for developing the digital model. From top to bottom, the four layers mapped are: (1) the Mississippi River alluvi-al aquifer and the shallow Pleistocene deposits, (2) the '400-foot' aquifer, (3) the '600-foot' aquifer, and (4) the '800-foot aquifer. Maps were prepared on a 1:24,000 scale base map of the industrial area at Baton Rouge and on a 1:125,000 scale base map of part of the five-parish study area. For each of the Baton Rouge and on a 1:125,000 scale base map of part of the five-parish study area. For each of the four layers, the altitude of the base of the unit, net sand thickness, and thickness of the clay between that unit and the next deeper unit were determined and contoured. The '400-foot' aquifer has the most continuous sands, ranging from 25 to 400 feet in thickness. Both the '600-foot' aquifers have large areas where no sand was found in the stratigraphic interval of the two aquifers. Clays of the shallow Pleistocene deposits form the confining unit above the '400-foot' aquifer. The shallow Pleistocene sands are discontinuous sand lenses within the shallow Pleistocene deposits. The Mississippi River alluvial aquifer is a thick sand

and gravel aquifer (200 to 600 ft in thickn and graver adulter (200 to 600 ft in thickness) that is in hydraulic connection with the '400-ft' and '600-ft' aquifers beneath parts of the Mississippi River alluvial plain. Confining beds between aquifers range from 0 feet in thickness, where sands of two aquifers coalesce, to over 400 ft in thickness, where one or more aquifers contain no sand. (Author's abstract) W91-11086

ASSESSMENT OF HYDROGEOLOGIC CONDITIONS WITH EMPHASIS ON WATER QUALITY AND WASTEWATER INJECTION, SOUTHWEST SARASOTA AND WEST CHARLOTTE COUNTIES, FLORIDA.

Geological Survey, Tallahassee, FL. Water Resources Div.
C. B. Hutchinson

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 90-709, 1991. 103p, 38 fig, 9 tab, 63 ref, append.

Descriptors: \*Florida, \*Geohydrology, \*Ground-water quality, \*Injection wells, \*Path of pollutants, \*Wastewater disposal, \*Water pollution sources, Aquifer systems, Aquifers, Groundwater move-ment, Mathematical models, Model studies, Perme-

The 250 sq mi area of southwest Sarasota and west Charlotte Counties is underlain by a complex geohydrologic system having diverse groundwater quality. The surficial and intermediate aquifer systems and the Upper Floridan aquifer of the Floridan aquifer systems contains its generate aquifering dan aquifer system contain six separate aquifers, or permeable zones, and have a total thickness of about 2,000 ft. Water in the clastic surficial aquifer about 2,000 ft. Water in the clastic surficial aquifer system is potable and is tapped by hundreds of shallow, low-yielding, supply wells. Water in the mixed clastic and carbonate intermediate aquifer system is potable in the upper part, but in the lower part, because of increasing salinity, it is used primarily for reverse osmosis desalinization feed water and irrigation. Potential groundwater contamination problems include flooding by storm tides unward movement of saline water toward. tides, upward movement of saline water toward pumping centers by natural and induced leakage or through improperly constructed and abandoned wells, and injected into deep zones. The study area encompasses seven wastewater injection sites that encompasses seven wastewater injection sites that have a projected capacity for injecting 29 million gallons per day (gpd) into the zone 1,100 to 2,050 ft below land surface. There are six additional sites within 20 miles. The numerical model was used to simulate injection through a representative well at a rate of 1 million gpd for 10 years. In this simulation, a convection cell developed around the injection well with the buoyant fresh injectant rising to form a lens within the injection your below the from a lens within the injection zone below the lower Suwannee-Ocala semiconfining unit. Around an ideal, fully penetrating well cased 50 ft into the injection zone and open from a depth of 1,150 ft to 2,050 ft, simulations show that the injectant moves upward to a depth of 940 ft, forms a lens about 600. If thick and correctly existing volume to the singulation should be supported to a depth of 940 ft, forms a lens about 600. upward to a depth of 940 ft, forms a lens about 600 ft thick and spreads radially outward to a distance of about 2,300 ft after 10 yrs. Comparison simulations of injection through wells with open depth intervals of 1,150 to 1,400 ft and 1,450 to 2,050 ft demonstrate that such changes in well construction have little effect on the area spread of the injectant lens or the rate of upward movement. (Lantz-PTT) W91-11087

GEOHYDROLOGY AND SIMULATION OF GROUND-WATER FLOW IN THE MESILLA BASIN, DONA ANA COUNTY, NEW MEXICO, AND EL PASO COUNTY, TEXAS. Geological Survey, Albuquerque, NM. Water Re-

sources Div. P. F. Frenzel, and C. A. Kaehler.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 88-305, 1990. 179p, 48 fig, 14 tab, 5 plates, 23 ref.

Descriptors: \*Geohydrology, \*Groundwater movement, \*Hydrologic models, \*Mesilla Basin, \*Model studies, \*New Mexico, \*Simulation analysis, \*Texas, Aquifers, Conductivity, Data interpre-

#### Group 2F-Groundwater

tation, Finite difference methods, Groundwater resources. Hydraulic head

The groundwater hydrology and geochemistry of the Mesilla Basin in central-southern New Mexico and western Texas were studied as part of the Southwest Alluvial Basins Regional Aquifer-System Analysis program of the US Geological Survey. The Mesilla Basin, hydrologically repre-sentative of many alluvial basins, was studied by seniative of many anitym oasins, was studied by simulating the groundwater flow system using a digital model. Groundwater flow generally is away from the Mesilla Valley near Las Cruces and toward the valley in the southern part of the basin. A finite difference groundwater flow model of the senior to the student of the senior to the sen basin simulated groundwater flow to and from the Rio Grande and a series of drains that empties into the Rio Grande. The model also simulated evapo-transpiration from non-irrigated lands in the Me-silla Valley (about 2 acre-ft/acre) as a function of the difference between the altitude of the land surface and the model derived altitude of the water surface and the model derived antitude of the water table. Hydraulic conductivity of the uppermost layer generally was about 22 ft/day where the layer represented the Santa Fe Group, and about 60 ft/day where the layer represented the flood 60 ft/day where the layer represented the flood plain alluvium plus the upper part of the underlying Santa Fe Group. Hydraulic conductivity of other layers ranged from about 22 ft/day for the upper part of the Santa Fe Group to 3 ft/day for the lower part. Model derived hydraulic heads, drain discharge, and river depletions compared well with measured values except that model-derived hydraulic heads in the Las Cruces well field area were about 20 ft higher than measured hydraulic heads according to simulations for the desired hydraulic heads. According to draulic heads. According to simulations for the 1970's, about 80% of groundwater pumped for nunicipal, industrial, and domestic uses may have come from the Rio Grande, about 10% from salvaged evapotranspiration, and about 10% from aquifer storage. Drawdowns of 1 to 10 ft in 1975 caused by historical non-irrigation withdrawals may be measurable at distances of about 5 mi west of well fields at Las Cruces and Canutillo in or below the deep producing zones. The chemical composition of groundwater in the Mesilla Valley varies areally and vertically. Along the northwestern margin of the basin, sulfate and sodium are the ern margin of the ossin, suntare and sodium are the dominant ions in groundwater flowing into the basin, and the specific conductance of this water ranges from 1,400 to 2,310 microsiemens/cm at 25 C. (Lantz-PTT) W91-11088

HYDROLOGIC. METEOROLOGICAL. MINOLOGICAL, AND UNSATURATED-ZONE MOISTURE-CONTENT DATA, FRANKING LAKE PLAYA, INYO COUNTY, CALIFORNIA.
Geological Survey, Denver, CO. Water Resources

J. B. Czarnecki.
Available from Books and Open Files Reports
Section, USGS Box 25425, Denver, CO 80225.
USGS Open File Report 89-595, 1990. 38p, 8 fig, 4
tab, 10 ref. DOE Interagency Agreement DEAI08-78ET44802.

Descriptors: \*Franklin Lake Playa, \*Geohydro-logy, \*Groundwater resources, \*Hydrologic data collections, \*Soil water, \*Surface-groundwater re-lations, \*Unsaturated zone, California, Evapotranspiration, Hydraulic gradient, Meteorology, Pie-zometry, Vertical flow, Water level.

Hydrologic and other data are presented which were collected to further characterize the geohydrology and groundwater discharge at Franklin Lake playa, Inyo County, California. These data include: (1) hydrographs of water levels in piezometers; (2) vertical hydraulic gradients estimated from piezometer-nest data; (3) meteorological data from weather stations in the vicinity of Franklin Lake playa; and (4) estimates of moisture fluxes based on changes in soil moisture content in the unsaturated zone. Hydrographs of water levels in piezometers vary from being very smooth to having extreme fluctuations. Average water level altitudes from these hydrographs can be used to contour the water table altitude in the vicinity of Franklin Lake playa. Vertical hydraulic gradients estimated from piezometer-nest data can be used to estimate groundwater discharge, provided reliable

estimates of vertical hydraulic conductivity are available. Evapotranspiration estimates based on changes in soil moisture content in the unsaturated zone provide a basis of comparison for other methods such as the energy budget eddy correlation technique. (Lantz-PTT) W91-11089

ANALYSIS OF GROUND-WATER FLOW IN THE A-SAND AQUIFER AT PARAMARIBO, SURINAME, SOUTH AMERICA. Geological Survey, Tallahassee, FL. Water Resources Div.

Sources Div.

C. B. Hutchinson.

Available from Books and Open Files Reports
Section, USGS Box 25425, Denver, CO 80225.

USGS Water-Resources Investigations Report 90-4036, 1990. 65p, 20 fig, 3 tab, 8 ref, 3 append.

Descriptors: \*Aquifers, \*Groundwater movement, \*Model studies, \*Saline water intrusion, \*Water quality control, Data interpretation, Flow velocity, Hydraulic conductivity, Paramaribo, Potentiometry, Simulation analysis, Suriname, Transmissi-

A numerical aquifer simulation model was developed for a 619 sq km area to help understand the groundwater flow system and to aid in the management of pumpage from the A-Sand aquifer in Paramaribo, Suriname. Thirty years of continuous increases in pumpage from the A-Sand aquifer have created broad cones of depression in the aquifer's potentiometric surface that extend over hundreds of square kilometers. As a result of these water level declines, the aquifer is experiencing water level declines, the aquifer is experiencing problems of well field interference and salt water problems of well field interference and salt water encroachment. Aquifer tests had indicated a large variability in hydraulic conductivity; however, an acceptable calibration was achieved by using a uniform hydraulic conductivity of 90 m/day. Simulated transmissivity of the 2-m to 50-m thick aquifer wedge varies from 180 to 4,500 sq m/d between the southern and northern model boundaries. There simulations were made to demonstrate aries. Three simulations were made to demonstrate how the model can be used as a tool for water management. A transient simulation was made to management. A transient simulation was made to assess potentiometric surface changes resulting from pumpage during the period 1958 to 1987. Potentiometric surface maps for selected years show expanding and coalescing cones of depression as the number of well fields increased from one to six and pumping rates increased from 1,643 to 40,230 cu m/d. A hypothetical new well field, with a 6,000 cu m/d pumping rate, was simulated to demonstrate how additional pumping can lower the potentiometric surface at existing well fields. Another simulation redistributed pumpage by adding the above hypothetical new well field, but adding the above hypothetical new weil neit, du with an equivalent reduction in pumpage at the two most heavily pumped well fields, Zorg en Hoop and Livorno. Head gradients between Zorg en Hoop and the area where chloride concentratin through and the area where contorned concentrations in groundwater exceed 300 mg/L, were compared with 1987 gradients to show that redistributing pumpage might slow salt water encroachment and extend the useful life of the well field by 5 years. A particle tracking program was used to assess results of the flow simulations. The simulational content of the simulations assess results of the flow simulations. The simulated velocity averages about 133 m/yr within 4 km of the Livorno well field. Simulated velocities from the area of high chloride concentrations are highest toward the Leysweg and Zorg en Hoop well fields, indicating a high potential for increasing chloride concentrations in water from these well fields (I seek BTC). well fields. (Lantz-PTT) W91-11090

GEOHYDROLOGY AND WATER QUALITY OF KALAMAZOO COUNTY, MICHIGAN, 1986-

Geological Survey, Lansing, MI. Water Resources

Div. S. J. Rheaume.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4028, 1990. 102p, 21 fig, 36 tab, 3 plates, 30 ref,

Descriptors: \*Geohydrology, \*Groundwater quality, \*Kalamazoo County, \*Water quality, Calcium

bicarbonate, Chlorides, Groundwater recharge, Michigan, Nitrogen, Organic compounds, Pesti-cides, Sodium, Sulfates, Surface water.

Thick, glacial sand and gravel deposits provide most groundwater supplies in Kalamazoo County. Most industry, public supply, and irrigation wells completed at depths of 100 to 200 ft yield 1,000 gallons per minute (gpm) or more. Groundwater levels in Kalamazoo County, reflect short-term and long-term changes in precipitation and local pump age. Groundwater levels increase in the spring and age. Groundwater levels increase in the spring and decline in the fall. Recharge rates, for different geologic settings, were estimated from groundwater runoff to the streams. A county-wide average groundwater recharge rate is estimated to be 9.32 in/yr. Water of streams and rivers of Kalvana groundwater recharge rate is estimated to be 9.32 in/yr. Water of streams and rivers of Kalamazoo County is predominantly of the calcium bicarbonate type, although dissolved sulfate concentrations are slightly larger in streams in the southeastern and northwestern parts of the county. Concentrations of dissolved chloride in streams draining urban industrial areas are slightly larger than at other locations. Concentrations of total nitrogen and total phosphorus in streams are directly proportional to streamflow. Except for elevated concentrations of iron, none of the trace elements in streams exceeded maximum contaminant levels for streams exceeded maximum contaminant levels for drinking water established by the US EPA. Pesticides were detected in some streams. Groundwater in the surficial aquifers is of the calcium bicarbonate type, although sodium, sulfate, and chloride ions predominate at some locations. Concentrations of dissolved sodium and dissolved chloride in 6 wells were greater than most natural groundwaters in the State, indicating possible contamination from road salts. Water samples from 6 of the 46 wells sampled contained concentrations of total nitrate as nitrogen > 10.0 mg/L. Pesticides were detected in water from only one well. Water from drinking water established by the US EPA. Pestidetected in water from only one well. Water from five wells contained volatile organics. (Lantz-PTT) W91-11091

GEOPHYSICAL AND CHEMICAL INVESTI-GATIONS OF GROUND WATER AT FIVE IN-DUSTRIAL OR WASTE-DISPOSAL SITES IN LOGAN TOWNSHIP, GLOUCESTER COUNTY, NEW JERSEY, 1983-87.

Geological Survey, West Trenton, NJ. For primary bibliographic entry see Field 5B. W91-11092

GEOHYDROLOGY AND SIMULATION OF FLOW IN THE CHICOT AQUIFER SYSTEM OF SOUTHWESTERN LOUISIANA.

Geological Survey, Baton Rouge, LA. Water Resources Div.

D. J. Nyman, K. J. Halford, and A. Martin. State of Louisiana Water Resources Technical Report No. 50, 1990. 58p, 33 fig, 5 tab, 40 ref.

Descriptors: \*Chicot Aquifer, \*Geohydrology, \*Groundwater movement, \*Louisiana, \*Model studies, \*Simulation analysis, Aquifers, Groundwater mining, Lake Charles, Leakage, Water level.

Water was pumped at about 1 billion gallons per day (gpd) from the Chicot aquifer system in 1980 by industry and rice growers in southwestern Lou-isiana. Records indicate that water levels in wells declined, on average, as much as 1 ft/yr from 1900 to 1981 in the Lake Charles and rice growing areas. Water levels rose, on average, 2 ft/yr during the period 1982-85 because pumping rates during the period were reduced by 38% to 616 million gpd. The Chicot aquifer system consists of a com-plex series of alternating beds of unconsolidated plex series of anternating oceas of unconsonated sand, gravel, silt, and clay. A digital groundwater flow model was developed to simulate flow in the Chicot aquifer system and to estimate the effects of pumping. In general, model computed water levels compare closely with observed levels. Model recompare closely with observed levels. Model re-sults indicate that: (1) flow patterns in the Chicot aquifer system have been significantly altered downgradient from the area of outcrop since pre-development; (2) approximately a fourfold increase (from 259 to 1,113 million gpd) in flow through the system has occurred since major development began; (3) water levels in and near the pumping centers declined, on average. I flyr from pre-centers declined, on average. ters declined, on average, 1 ft/yr from pre

#### Groundwater-Group 2F

development to 1981; (4) under 1981 conditions, vertical leakage was the largest component of re-charge; and (5) water derived from aquifer storage is a relatively small part of flow in the entire system. The model is least sensitive to changes in system. The model is least sensitive to changes in a quifer storage and most sensitive to changes in the vertical conductance of the confining units. Simu-lations indicate that, disregarding the possibility of salt water encroachment in the aquifers along the coast, pumping rates 50% to 100% larger than the 1980 rate can be maintained indefinitely with the available recharge. (Author's abstract) W91-11100

AVAILABILITY OF GROUND WATER FROM UNCONSOLIDATED DEPOSITS IN THE MOHAWK RIVER BASIN, NEW YORK. Geological Survey, Albany, NY. Water Resources

Div. R. J. Reynolds.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4091, 1990. 9p, 10 maps, 175 ref.

Descriptors: \*Geohydrology, \*Groundwater movement, \*Groundwater resources, \*Maps, \*Mohawk River Basin, \*New York, \*Unconsoli-dated aquifers, Aquifer systems, Geology, Hydro-logic data collections, Well yield, Wells.

Information on the availability of groundwater from unconsolidated deposits has become increasingly important in water resource planning and management. State, county, and local agencies charged with providing adequate water supplies and safeguarding New York's groundwater quality need to know the location of unconsolidated aquifers that have the potential for water supply. To meet this need, the US Geological Survey, in cooperation with the New York State Department of Environmental Conservation, has undertaken an aquifer-mapping program in upstate New York to provide: (1) detailed geohydrologic mapping of selected aquifers that serve large population cen-ters at a scale of 1:24,000, and (2) reconnaissancetype geohydrologic information on each major river basin in New York at a scale of 1:125,000 or 1:250,000. This report shows the location of unconsolidated deposits with the Mohawk River basin at a:125,000 scale and gives the estimated potential yield of wells that are completed in these deposits. The basin is divided into three parts—east, south, and west-each of which is represented by three maps that show, respectively: (1) location, reported yield, diameter, and depth of wells that terminate in unconsolidated deposits; (2) surficial geology; and (3) estimated yields of wells that tap unconsolidated deposits. (Lantz-PTT)

HYDROGEOLOGY OF THE VALLEY-FILL AQUIFER AT OWEGO, TIOGA COUNTY, NEW YORK.

Geological Survey, Albany, NY. Water Resources

Geological Survey, Albany, NY. water Resources Div. R. J. Reynolds, and J. D. Garry. Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4000, 1990. 8p, 8 maps, 32 ref.

Descriptors: \*Aquifer systems, \*Geohydrology, \*Groundwater resources, \*Maps, \*New York, Geology, Hydrologic data collections, Land use, Owego, Permeability, Saturation, Water level, Water table, Well yield.

Most productive aquifers in upstate New York consist of unconsolidated deposits of glacial and alluvial sand and gravel that floor major river and stream valleys. Groundwater in these valley-fill aquifers can occur under either water table (unconfined) or artesian (confined) conditions. Farms, fined) or artesian (confined) conditions. Farms, industries, or municipalities overlie many of these aquifers because they typically form flat areas that are suitable for development, and generally provide an ample groundwater supply. This development, coupled with the generally high permeability of these deposits, and a typically shallow water depth to the water table, makes these aquifers

vulnerable to contamination from point sources such as landfills, road salt stockpiles, hydrocarbon fuel storage and other industrial facilities with a potential for contamination leakage, in addition to nonpoint sources such as urban and agricultural runoff and septic tank leachate. To facilitate water management decisions by State and local govern-ment agencies, the US Geological Survey, in coop-eration with the New York State Department of eration with the New York State Department of Health, began a study in 1980 to define the geohydrology of 18 extensively used unconsolidated aquifers in upstate New York. To date (1989) 15 of these aquifers have been studied and the results published as individual reports (at 1:24,000 scale). This set of maps summarizes the geohydrology of the valley fill aquifer system near Owego, in Tioga County, NY. The maps are based on geohydrologic data collected near Owego during this investigation and on data in US Geological Survey files and previously published Geological Survey reports. These data enabled the compilation of eight sheets: locations of wells and test holes (sheet 1), surficial geology (sheet 2), geologic sections (sheet surficial geology (sheet 2), geologic sections (sheet 3), water table altitude (sheet 4), saturated thickness of the valley-fill aquifer (sheet 5), estimated well yields (sheet 6), generalized soil permeability (sheet 7), and land use (sheet 8). (Lantz-PTT) W91-11105

EVALUATION OF THREE SCENARIOS OF GROUND-WATER WITHDRAWAL FROM THE MISSISSIPPI RIVER ALLUVIAL AQUIFER IN NORTHWESTERN MISSISSIPPI. Geological Survey, Jackson, MS. Water Resources Div

For primary bibliographic entry see Field 4B. W91-11106

HYDROLOGY OF THE FLORIDAN AQUIFER SYSTEM IN EAST-CENTRAL FLORIDA.

C. N. Tiboais. Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Professional Paper 1403-E, 1990. 98p, 78 fig, 8 tab, 213 ref, 3 app

Descriptors: \*Florida, \*Floridan Aquifer, \*Geohydrology, \*Groundwater movement, \*Groundwater Descriptors: Priorida, Priorida Aquifer, "Geohydrology, "Groundwater movement, "Groundwater resources, "Permeability, Aquifer systems, Aquifers, Dissolved solids, Groundwater discharge, Groundwater quality, Groundwater recharge, Mineralization, Simulation analysis, Transmission,"

The fresh groundwater flow system of east-central Florida consists of a thin surficial sand aquifer underlain by the thick, highly productive carbonate rocks of the Floridan aquifer system. On the basis of permeability, this system is divided into the Upper and Lower Floridan aquifers, which are separated by a less permeable limestone sequence referred to as the 'middle semiconfining unit.' The transmissivity of the Lower Floridan is less well known, but simulation suggests values in the range of 30,000 to 130,000 sq ft/day. Storage coefficients of both the Upper and Lower Floridan aquifers are about 0.001. Leakage coefficients of the confining bed that overlies the Upper Floridan range from 0.00001/4 to about 0.0006/d. The leakage coefficient of the middle semiconfining unit is about 0.00005/d. The chemical quality of the water in the Upper Floridan qualifer varies according to The fresh groundwater flow system of east-central 0.0005/d. The chemical quality of the water in the Upper Floridan aquifer varies according to proximity to recharge and discharge areas. Low concentrations of dissolved solids (< 250 mg/L) generally occur in recharge areas. However, in the discharge areas along the Atlantic Coast and along the St. Johns River, the dissolved solids concentration is generally > 1.000 mg/L, and in places exceeds 25,000 mg/L. The quality of water in the Lower Floridan is not well defined, but in east-central Florida, water in the Lower Floridan is probably more mineralized than water in the Upper Floridan. The hydraulics of the Floridan aquifer system under predevelopment conditions Upper Floridan. The hydraulics of the Floridan aquifer system under predevelopment conditions involve mostly recharge to the Upper Floridan (by way of leakage from the surficial aquifer), lateral movement through the Upper Floridan for short distances, and discharge by way of springs and seepage to streams. Relatively small amounts of discharge occur along the coast, and small amounts move into and out of the underlying Lower Flori-

dan. The imposition of pumping has altered the flow system, but not to a great degree. (Lantz-W91-11113

HYDROGEOLOGY OF THE POINT LOOK-OUT SANDSTONE IN THE SAN JUAN STRUC-TURAL BASIN, NEW MEXICO, COLORADO, ARIZONA, AND UTAH.

S. D. Craigg, W. L. Dam, J. M. Kernodle, C. R. Thorn, and G. W. Levings.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Hydrologic Investigation Atlas HA-720-G, 1990. 2p, 12 fig, 33 ref.

Descriptors: \*Geohydrology, \*Groundwater quality, "Groundwater resources, "New Mexico, "Point Lookout Sandstone, "Regional Aquifer System Analysis, Aquifers, Arizona, Chlorides, Colorado, Dissolved solids, Drinking water, Fluorides, Groundwater discharge, Hydrogen ion concentration, Infiltration, Sandstones, Sulfates, Utah.

This report is one in a series resulting from the US Geological Survey's Regional Aquifer-System Analysis (RASA) study of the San Juan structural basin that began in October 1984. Summarized is information on the geology, occurrence and qual-ity of water in the Point Lookout Sandstone, one ity of water in the Point Lookout Sanastone, one of the primary water-bearing units in the regional aquifer system. The Point Lookout Sandstone is a source of water for domestic and livestock use in dilling denths and pumping levels are source of water for domestic and livestock use in areas where drilling depths and pumping levels are economically feasible and where water quality is acceptable. Water in the Point Lookout Sandstone occurs under both water table and artesian conditions. Potential recharge to the aquifer is from infiltration of precipitation and streamflow and from vertical leakage of water through confining beds. Reported transmissivity of the Point Lookout Sandstone ranges from 0.4 sq ft/d to 236 sq ft/d. A storage coefficient of 0.000041 was reported from drawdown in an observation well. The average hydraulic conductivity calculated from oil and gas hydraulic conductivity calculated from oil and g wells in the deeper parts of the basin is 0.0058 ft/d. The reported or measured discharge from 17 water Ine reported or measured discharge from I / water wells completed in the Point Lookout Sandstone ranges from 1 to 75 gallons per minute (gpm) and the median is 10 gpm/ft of drawdown and the median is 0.25 gpm/ft of drawdown. From a total of 37 samples for pH, 22 (59%) exceeded the standard. Out of a total of 43 samples for sulfate, 16 standard. Out of a total of 43 samples for suitrate, 10 samples (37%) exceeded the secondary drinking water standard. Only 1 sample for chloride out of 49 samples (2%) exceeded the standard. From 44 samples for fluoride, 9 samples (20%) exceeded the secondary drinking water standard of 4 mg/L. Twenty-nine samples (69%) from a total of 42 samples for dissolved solids concentration exceeded the secondary drinking water standard. No secondary drinking water standard. ed the secondary drinking water standard. No samples for nitrate exceeded the primary drinking water standard of 10 mg/L. (Lantz-PTT)

AGRICHEMICALS AND GROUNDWATER PROTECTION: RESOURCES AND STRATE-GIES FOR STATE AND LOCAL MANAGE-

For primary bibliographic entry see Field 5G. W91-11162

MINNESOTA DISTRICT, WATER RE-SOURCES DIVISION: INFORMATION AND TECHNICAL ASSISTANCE.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Man-agement. Freshwater Foundation, Navarre, Minne-sota. 1989. p 93-97.

Descriptors: \*Data acquisition, \*Data interpreta-tion, \*Geological surveys, \*Hydrologic data col-lections, \*Minnesota, \*Nonpoint pollution sources, \*Water resource institutions, Agricultural chemi-cals, Agricultural practices, Aquifers, Geohydro-logy, Groundwater pollution, Groundwater qual-ity, Hydrologic studies, Streamflow, Water qual-ity, Water resources.

#### Group 2F-Groundwater

The Minnesota District of the U.S. Geological Survey's Water Resources Division is an earth-sciences agency whose job is to collect and interpret water resources data. During FY 1988, 56% of the District's program consisted of hydrologic studies and 44% hydrologic data collection. During this period, the District operated 145 well level stations; 79 daily streamflow stations, 93 high flow, partial record stations, 6 lake level stations; and 10 stage only stations. Water quality data were also collected at 5 sediment stations; 8 National Stream Quality Accounting Network stations; 2 Hydrologic Benchmark stations; and 6 miscellaneous water-quality stations. Four studies, which have been completed or are being worked on, are on agrichemicals in groundwater. These included the effects of agriculture, tillage, and rural residential development on water quality in surficial sandplain aquifers. The District also conducted 11 hydrologic Studies not directly related to agrichemicals in groundwater. These studies covered the major discipline ages of surface water, groundcals in groundwater. These studies covered the major discipline areas of surface water, groundwater, and water quality, as well as their interrela-tionships. (See also W91-11162) ( Rubinstein-PTT) W91-11167

INNOVATIVE SUBSURFACE SEWAGE MAN-AGEMENT: A PROGRAM TO PROTECT IDAHO'S RATHDRUM PRAIRIE AQUIFER. For primary bibliographic entry see Field 5G. W91-11186

BIODEGRADATION OF HYDROCARBON VAPORS IN THE UNSATURATED ZONE. Massachusetts Univ., Amherst. Dept. of Civil En-For primary bibliographic entry see Field 5B. W91-11227

THEORETICAL STUDY OF THE SIGNIFICANCE OF NONEQUILIBRIUM DISSOLUTION OF NONAQUEOUS PHASE LIQUIDS IN SUBSURFACE SYSTEMS.

Michigan Univ., Ann Arbor. Dept. of Environ-mental and Water Resources Engineering. For primary bibliographic entry see Field 5B. W91-11228

GEOSTATISTICAL CHARACTERISTICS OF THE BORDEN AQUIFER.

Manitoba Univ., Winnipeg. Dept. of Geological

Engineering.
A. D. Woodbury, and E. A. Sudicky.
Water Resources Research WRERAQ, Vol. 27,
No. 4, p 533-546, April 1991. 10 fig, 8 tab, 45 ref,

Descriptors: \*Borden Aquifer, \*Data interpreta-tion, \*Geohydrology, \*Hydraulic conductivity, \*Path of pollutants, \*Plumes, \*Statistical analysis, \*Tracers, Groundwater pollution, Mathematical models, Ontario, Performance evaluation.

A field experiment for the geostatistical characterration of hydraulic conductivity and plume dispersion in the Borden aquifer, Ontario, was reexamined. The sampled data reveal that a number of outliers (low natural log (K) values) are present in the database. These low values cause difficulties in both variogram estimation and determining population statistics. The analysis shows that assuming either a normal distribution or an exponential dis-tribution for log conductivity is appropriate. The classical, Cressie/Hawkins, and squared median of the absolute deviation estimators were used to compute variograms. None of these estimators procompute variograms. None of these estimators provided completely satisfactory variograms for the Borden data except the classical estimator with outliers removed from the data set. Theoretical exponential variogram parameters were determined from nonlinear (NL) estimation. Differences were obtained between NL fits and those reported by Sudicky in 1986. For the classical-screened estimated variogram, NL fits reduces natural log estimated variogram. NL fits reduces natural log of Studies in 1760. For the classical-screening estimated variogram, NL fits produce a natural log (K) variance of 0.24, nugget of 0.07, and integral scales of 5.1 m horizontal and 0.21 m vertical along A-A'. For B-B' these values are 0.37, 0.11, 8.3, and 0.34. The fitted parameter set for B-B' data (horizontal and vertical) differed statistically from the

parameter set determined for A-A'. A probabalistic form of Dagan's equations relating geostatistical parameters to a tracer cloud's spreading moments also was evaluated using the parameter estimates and covariances determined from line A-A' as and covariances determined from the APA as input, with a velocity equal to 9.0 cm/day. The results were compared with actual values determined from the field test, but evaluated by the methods of both Freyberg and Rajaram and Gelhar. The geostatistical parameters developed produce an excellent fit to both sets of calculated plume moments when combined with Dagan's sto-chastic theory for predicting the spread of a tracer cloud. (Author's abstract) W91-11234

ANALYTICAL MODELING OF AQUIFER DE-CONTAMINATION BY PUMPING WHEN TRANSPORT IS AFFECTED BY RATE-LIMIT-ED SORPTION.

Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Civil Engineering. For primary bibliographic entry see Field 5G. W91-11235

RESPONSE OF WATER LEVEL IN A WELL TO A TIME SERIES OF ATMOSPHERIC LOADING UNDER CONFINED CONDITIONS, Florida State Univ., Tallahassee. Dept. of Geolo-

D. J. Furbish. Water Resources Research WRERAQ, Vol. 27, No. 4, p 557-568, April 1991. 15 fig, 1 tab, 29 ref,

Descriptors: \*Atmospheric pressure, \*Confined aquifers, \*Geohydrology, \*Groundwater level, \*Groundwater movement, \*Mathematical models, \*Water level, \*Wells, Aquifers, Simulation, Storativity. Time series analysis.

The water level in a well that penetrates a confined aquifer can fluctuate in response to changes in atmospheric pressure. The response varies with the well casing and screen dimensions, the transmissi-vity, and compressibility of the aquifer, and to a small extent, its storativity. Recently this loading-pressure problem has been solved in terms of a pressure problem has been solved in terms of a frequency response function that characterizes how attenuation and phase shifts in the response signal vary with frequency. The counterpart of this solution in the time domain is an impulse response function. This solution has the immediate appeal that it can be used directly to filter raw loading and water level records via serial convolution, where the response at any time is a weighted aggregate of the previous loading signal. The im-pulse response function derives from well-known solutions to the slug test problem. When based on the Cooper-Bredehoeft-Papadopulos solution, the response function is precise but computationally intensive. Based on the Hvorsley solution, the reintensive. Based on the Hvorslev solution, the response function is computationally simple, but applicable only to aquifers with small storativity. Simulations and a field example clearly illustrate the dominating influence of transmissivity in dampening and lagging the response of a confined aquifer to a loading signal, and how both effects increase with higher frequency. The results also illustrate the weak influence of storativity in modulating the response signal. (Author's abstract) W91-11236

OPTIMAL DATA ACQUISITION STRATEGY FOR THE DEVELOPMENT OF A TRANSPORT MODEL FOR GROUNDWATER REMEDI-

Facolta di Ingegneria, Reggio Calabria, Italy.
For primary bibliographic entry see Field 5G.
W91-11238

APPLICATION OF A MULTIPROCESS NONE-QUILIBRIUM SORPTION MODEL TO SOLUTE TRANSPORT IN A STRATIFIED POROUS MEDIUM. Arizona Univ., Tucson. Dept. of Soil and Water

Science. For primary bibliographic entry see Field 5B. W91-11239 EVALUATION OF ANALYTICAL SOLUTIONS TO ESTIMATE DRAWDOWNS AND STREAM DEPLETIONS BY WELLS.

GeoTrans, Inc., Herndon, VA C. P. Spalding, and R. Khaleel.

Water Resources Research WRERAQ, Vol. 27, No. 4, p 597-609, April 1991. 18 fig, 3 tab, 26 ref.

Descriptors: \*Drawdown, \*Pumping tests, \*Surface-groundwater relations, \*Wells, Aquifers, Errors, Groundwater budget, Hydraulic properties, Mathematical models, Model studies, Simula-

Analytical solutions for computing drawdowns and streamflow depletion rates often neglect conditions that exist in typical stream-aquifier systems. These conditions include: (1) partial penetration of the aquifer by a stream, (2) presence of a streambed clogging layer, (3) aquifer storage available to the pumping well from areas beyond the stream, and (4) hydraulic disconnection between the stream and the well. A methodology was devised for estimating extended flow lengths and other parameters used to approximate the increased head losses created by partially penetrating streams and clogging layer resistance effects. The computed stream depletion rates and drawdown distributions from several analytical solutions (Theis, Glover and several analytical solutions (Theis, Glover and Balmer, Jacob, Hantush) were compared to those obtained using a two-dimensional groundwater flow model. The stream geometry was approximated as a semicircle. Numerical simulation results indicate that, because of the use of simplifying assumptions, the analytical solutions can misrepreassumptions, the analytical solutions can misrepre-sent aquifer drawdown distributions and overesti-mate stream depletion rates. Assuming that a cor-rect simulation of the stream depletion phenome-non is provided by the numerical model, the error associated with each of the simplifying assumptions was determined. At a time of \$8.5 days after pump-tion became across in computed, stream depletion was determined. At a time of 3-8.3 days atter pumping began, errors in computed stream depletion rates due to neglect of partial penetration were 20%, those due to neglect of clogging layer resistance were 45%, and those due to neglect of storage areas beyond the stream were 21%. Neglecting hydraulic disconnection had only a minor effect (i.e., an error of 1% only at a time of 58.5 days after pumping began) on computed stream deple-tion rates and a noticeable effect on aquifer drawdown distributions. (Author's abstract) W91-11240

DIFFUSION IN FRACTAL POROUS MEDIA. Purdue Univ., Lafayette, IN. Dept. of Agronomy. I H Cushman

Water Resources Research WRERAQ, Vol. 27, No. 4, p 643-644, April 1991. 3 ref. US DOE Grant DE-FG02-85ER-60310.

Descriptors: \*Diffusion, \*Fractals, \*Geohydrology, \*Groundwater movement, \*Mathematical studies, \*Porous media, Mathematical equations, Molecular hydrodynamics, Solute transport, Ther-

Generalized molecular hydrodynamics and irre-Generalized molecular hydrodynamics and irre-versible thermodynamics are used to derive the relation between a general wave vector and fre-quency-dependent diffusion tensor and the power spectral density. A non-local integrodifferential equation is the result. Among its physical implica-tions, the most important is that transport at a given point depends on all prior history of the transport process and on what is happening every-where else in space. This is in complete intuitive agreement with what would be excetted in fractal where eise in space. Insis in complete intuitive agreement with what would be expected in fractal porous media. The equation is a nonlocal extension of the classical Markovian equation for diffusion. An example of how the developed concepts can be applied in an isotropic fractal porous medium is presented. (Rochester-PTT) W91-11243

HYDROCHEMISTRY OF A GROUNDWATER-SEAWATER MIXING ZONE, NAURU ISLAND, CENTRAL PACIFIC OCEAN.

New South Wales Univ., Kensington (Australia). Centre for Groundwater Management and Hydro-

#### Groundwater-Group 2F

For primary bibliographic entry see Field 2K. W91-11297

STRATEGY FOR PESTICIDE CONTROL IN GROUND WATER AND DRINKING WATER. Karlsruhe Univ. (Germany, F.R.). DVG-Forschungsstelle am Engler-Bunte-Inst. For primary bibliographic entry see Field 5A. W91-11312

STUDIES OF SPRINGS IN THE SOUTHERN PART OF THE VALLEY OF MEXICO (ESTUDIO CRENOLOGICO EN LA PARTE MERIDIONAL DE LA CUENCA DE MEXICO). Wroclaw Univ. (Poland). Inst. Geograficzny. For primary bibliographic entry see Field 2E. W91-11352

USE OF ELECTRONIC DATA-LOGGING EQUIPMENT TO MONITOR HYDROLOGIC PARAMETERS IN A HUMID CAVE ENVIRONMENT IN WIND CAVE NATIONAL PARK, SOUTH DAKOTA.

For primary bibliographic entry see Field 7B. W91-11389

GEOCHEMICAL EVOLUTION OF GROUND WATER IN SMITH CREEK VALLEY-A HYDROLOGICALLY CLOSED BASIN IN CENTRAL NEVADA, U.S.A. Geological Survey, Carson City, NV. For primary bibliographic entry see Field 2K. W91-11392

GRAPHICAL METHOD FOR DETERMINING THE COEFFICIENT OF CONSOLIDATION CV FROM A FLOW-PUMP PERMEABILITY TEST. Geological Survey, Denver, CO. For primary bibliographic entry see Field 7C. W91-11393

APPLICATION OF UPHOLE DATA FROM PETROLEUM SEISMIC SURVEYS TO GROUNDWATER INVESTIGATIONS, ABU DHABI (UNITED ARAB EMIRATES). Geological Survey, Tacoma, WA. For primary bibliographic entry see Field 7C. W91-11399

GROUND WATER CONTAMINATION FROM AGRICULTURAL SOURCES: IMPLICATIONS FOR VOLUNTARY POLICY ADHERENCE FROM IOWA AND VIRGINIA FARMER'S AT-

New Hampshire Univ., Durham. Dept. of Resource Economics and Community Development. For primary bibliographic entry see Field 5G. W91-11437

GROUND-WATER CONTROL OF EVAPORITE DEPOSITION.

Geological Survey, Reston, VA.
For primary bibliographic entry see Field 2K. For primary W91-11438

AQUIFERS IN THE BENIN FORMATION (MIOCENE-RECENT), EASTERN NIGER DELTA, NIGERIA: LITHOSTRATIGRAPHY, HYDRAULICS, AND WATER QUALITY.
Port Harcourt Univ. (Nigeria). Dept. of Geology. L. C. Amajor.

E. C. Alliajor. Environmental Geology and Water Sciences EGWSEI, Vol. 17, No. 2, p 85-101, March/April 1991. 16 fig. 1 tab, 25 ref.

Descriptors: \*Aquifer characteristics, \*Aquifers, \*Geohydrology, \*Groundwater pollution, \*Groundwater quality, \*Nigeria, Boreholes, Conglomerate, Groundwater management, Lignite, Lithology, Rivers State, Saline water intrusion, Stratigraphy.

The Benin formation, formerly thought of as com-pletely continental in origin, contains brackish

water and marine deposits within its upper 0 to 300 meter section in places in Rivers State, Nigeria. The dominantly north to south flowing groundwater system, with excellent hydraulic characteristics, is abstracted from fluvial channel sands in the north and tidal channel, intertidal, and beach sands in the central and southern sectors of the state. The groundwater is contaminated in places by the leaching of pyritic lignites, iron stained/coated, clasts/grains, laterite clasts, and brackish water invasion from the creeks. Conglomerate and lignite beds, within the depth interval considered in this seas, winin the depth interval considered in this study, are more common in the northeast and eastern parts of the state. More borehole drilling in the area will generate more subsurface data that will be useful in improving the stratigraphic framework. (Author's abstract)
W91-11443

DEFORESTATION AND LEACHING OF NITROGEN AS NITRATES INTO UNDERGROUND WATER IN INTERTROPICAL ZONES: THE EXAMPLE OF COTE D'IVOIRE. Montpellier-2 Univ. (France). Lab. d'Hydrogeolo-

gie.
J. P. Faillat, and A. Rambaud.
Environmental Geology and Water Sciences
EGWSEI, Vol. 17, No. 2, p 133-140, March/April
1991. 6 fig, 4 tab, 30 ref.

Descriptors: \*Deforestation, \*Groundwater pollution, \*Leaching, \*Nitrates, \*Nitrogen, \*Rural areas, \*Water pollution sources, \*Wells, \*West Africa, Path of pollutants, Potable water, Statisti-

Thousands of wells have been dug in most French-speaking countries in West Africa to supply rural populations with potable underground water through village hydraulic programs. Many of these wells are located in endogenous granitogeneissic or slaty sandstonelike rocks that lie beneath 5-40 meters of weathered and decayed material. Most of these wells have a total depth of 40-70 meters, a daily discharge of about 10 cubic meters, and in-stantaneous discharges of 1-5 cu m/h. In spite of favorable hydrogeological and environmental con-ditions, many of these wells display high nitrate contents. A statistical approach on a regional scale was used to determine the cause of the high nitrate contents. It was determined that the source of contents. It was determined that the source of nitrates is linked mainly with localized deforestation by man. (Author's abstract) W91-11446

SOURCES AND EXTENT OF GROUNDWATER CONTAMINATION. For primary bibliographic entry see Field 5B. W91-11546

NEW APPROACH TO TRACER TRANSPORT ANALYSIS: FROM FRACTURE SYSTEMS TO STRONGLY HETEROGENEOUS POROUS MEDIA.

MEDIA.
Lawrence Berkeley Lab., CA. Earth Sciences Div.
C. F. Tsang.
Available from the National Technical Information
Service, Springfield, VA. 22161, as DE89-012848.
Price codes: A03 in paper copy, A01 in microfiche.
Report No. LBL—27031, February 1989. 25p, 15
fig. 30 ref. DOE Contract No. DE-AC0376SF00098.

Descriptors: \*Tracers, \*Environmental tracers, \*Porous media, \*Heterogeneity, \*Groundwater movement, \*Data acquisition, Permeability, Porosity, Geohydrology, Statistical analysis.

Many current developments and utilizations of groundwater resources first require a study of their flow and transport properties. These properties are needed to evaluate possible changes in groundwater quality and the potential transport of hazardous solutes through the groundwater system. Investigation of transport properties of fractured rocks is an active area of research. Most of the current approaches to the study of flow and transport in fractured rocks cannot be easily used for analysis of tracer transport field data. A new approach is proposed based on a detailed study of transport

through a fracture of variable aperture-a twothrough a fracture of variable aperture—a two-dimensional strongly heterogeneous permeable system. It is suggested that tracer breathrough curves can be analyzed based on an aperture or permeability probability distribution function that characterizes the tracer flow through the fracture. The results can be extended to both a multi-fracture system and a strongly heterogeneous porous medium. Two major conclusions are: (1) Heterogemedium. Two major conclusions are: (1) Heterogeneity in fractures and also in porous media gives rise to flow channeling effects. Tracer transport through these flow channels can be characterized by a permeability probability distribution function. The mean of this distribution function is larger than that of the permeability probability function over the entire 2-D heterogeneous medium. Tracer concentration breakthrough curves can then be analyzed to obtain the parameters (mean and varianalyzed to obtain the parameters (mean and variance) of the permeability probability distribution function; and (2) Since this is a statistical approach to interpret tracer transport data, it is shown that it would be impossible to make accurate predictions would be impossible to make accurate predictions of tracer arrival concentrations at a point in time and space, due to local permeability variations. It is demonstrated that multiple-point or line/areal measurements of tracer transport should be made over a few spatial correlation lengths, that would average the variability and may yield dispersion parameter characteristic of the medium. In other words, this new approach may not be able to make point predictions of tracer transport, but may be able to predict tracer concentration over a region able to predict tracer concentration over a region of space. In many practical applications, perhaps this capability is all that is required. (Lantz-PTT) W91-11554

PIPING AND PSEUDOKARST IN DRYLANDS. G. G. Parker, and C. G. Higgins.

Geological Society of America Special Paper 252, 1990. p 101-110, 2 fig, 1 tab, 140 ref.

Descriptors: \*Piping, \*Pseudokarst, \*Groundwater movement, \*Erosion, \*Soil piping, \*Subsurface drainage, Soil water, Storm seepage, Arid lands, Gullies, Geohydrology, Storm runoff, Drainage.

Piping, a form of subsurface erosion that by several processes produces subterranean drainage conduits or tunnels in relatively insoluble materials, occurs widely in the Earth's drylands. It can affect hard, consolidated rock such as shale, claystone, and consonated rock such as snate, claystone, and siltstone, and even some sandstones and volcanic breccias. Silty sediments with 20% to 25% smectite clay and high exchangeable sodium content are especially susceptible to piping. Piping sites range from valley bottoms and stream terraces to uplands. Rainfall, snowmelt runoff, or irrigation water sinks into the ground or is diverted into water sinks into the ground or is diverted into water sinks into the ground or is diverted into surface openings, most commonly desiscation cracks. The water then seeps downward through the soil or follows vertical openings until it reaches an especially permeable layer or is blocked by an impermeable horizon. It seeps laterally downgradient toward an outlet in a surface drainage feature such as gully. Where the water emerges at the gully wall—sa a seep at first, later as a more concentrated flow-grains of sediment are entrained, thus initiating an incinient ripe. With the passage thus initiating an incipient pipe. With the passage of time and runoff events the tiny opening enof time and runoff events the tiny opening en-larges, extends headward upgradient, and finally grows so large that its roof caves in. This forms a new, small, ragged, lateral gully as a tributary to the parent gully. With time, more gullies form, and a large gully network develops. One result of such the parent guily, with time, more guilies form, and a large guily network develops. One result of such piping erosion is the development of landforms much like those of typical limestone karst terrains. Such landscapes are called pseudokarsts, and their features may include sinks, natural bridges, hanging dry valleys, disappearing streams, and subterranean drainage. Pseudokarst develops chiefly by subsurface grain-by-grain erosion of largely insoluble materials, whereas true karst is formed by molecule-by-molecule removal of dissolved ions from soluble rocks such as limestone, dolomite, and gypsum. Pseudokarst developed in soft valley fills may be altered radically by the effects of a single heavy rainstorm or snowmelt runoff. Gully heads have been known to retreat 10 m or more in such an event. However, pseudokarst developed in resistant rocks may last much longer. For instance, that near Round Rock, Arizona, has changed only

#### Group 2F-Groundwater

slightly in the 20-odd years since first observed in 1961. (Lantz-PTT) W91-11561

GEOLOGIC FRAMEWORK OF THE COLUMBIA PLATEAU AQUIFER SYSTEM, WASH-INGTON, OREGON, AND IDAHO.
Geological Survey, Portland, OR. Water Resources Div.
B. W. Drost, K. J. Whiteman, and J. B. Gonthier.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225.
USGS Water-Resources Investigations Report 87-4238, 1990. 10p, 1 fig, 48 ref, 10 maps.

Descriptors: \*Aquifer systems, \*Columbia Plateau Aquifer System, \*Geohydrology, \*Groundwater resources, \*Idaho, \*Maps, \*Oregon, \*Regional Aquifer Systems Analysis, Aquifers, Geologic fractures, Geology, Hydrologic data collections, Weshiretsen

The Columbia Plateau in eastern Washington, north-central and northeastern Oregon, and western Idaho covers > 70,000 a mi underlain chiefly by basalt belonging to the Columbia River Basalt Group. The Plateau is a large structural basin whose deepest part lies near Pasco, Washington, where the total thickness of basalt may exceed 14,000 ft. The Columbia Plateau regional aquifer system is a major aquifer system that consists chiefly of a great thickness of basalt belonging to the Columbia River Basalt Group, of minor interbedded sedimentary materials, and of overlying undivided consolidated and unconsolidated sediments. ded sedimentary materials, and of overlying undi-vided consolidated and unconsolidated sediments. For hydrologic purposes, these rocks have been subdivided along stratigraphic boundaries into four geohydrologic units. These geohydrologic units are from oldest to youngest: the Grande Ronde, Wanapum, Saddle Mountains, and overburden units. Structure contour and thickness maps have been prepared for each unit and for selected sedi-mentary interbeds in this study. The Grande Ronde is the thickest most extensive geohydrolo-Ronde is the thickest most extensive geonydrolo-gic unit; each of the overlying younger units in turn cover less area and are less voluminous. Thicknesses of each unit range from a minimum of zero to a maximum of about 14,000 ft for the Grande Ronde, 1,200 ft for the Wanapum, and 800 ft for the Saddle Mountain geohydrologic unit. The maximum thicknesses for each of the geohy-The maximum thicknesses for each of the geony-drologic units occur near the deepest part of the structural basin near Pasco, Washington. The thickest overburden, 2,000 ft, occurs in the Grande Ronde Valley near La Grande, Oregon, but is generally much thinner elsewhere. This report contains ten separate sheets. Each sheet describes in greater detail that part of the geologic framework that it represents: geologic map (sheet b). work that it represents: geologic map (sheet 1); structural features (sheet 2); altitude of top of Grande Ronde Basalt and thickness of Grande Ronde geohydrologic unit (sheet 3); thickness of Wanapum-Grande Ronde interbed (sheet 4); thick-Wanapum-Grande Ronde interbed (sheet 4); thickness of Wanapum geohydrologic unit (sheet 5); altitude of top of Wanapum Basalt (sheet 6); thickness of Saddle Mountains-Wanapum interbed (sheet 7); thickness of Saddle Mountains geohydrologic unit (sheet 8); altitude of top of Saddle Mountains Basalt (sheet 9); and thickness of overburden (sheet 10). (Lantz-PTT)
W91-11571

HYDROGEOLOGY, WATER QUALITY, AND GROUND-WATER DEVELOPMENT ALTER-NATIVES IN THE LOWER WOOD RIVER GROUND-WATER RESERVOIR, RHODE ISLAND.

Geological Survey, Providence, RI. Water Resources Div.

D. C. Dickerman, E. C. Todd Trench, and J. P.

Russen.
Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4031, 1990. 109p, 30 fig. 15 tab, 59 ref.

Descriptors: \*Geohydrology, \*Groundwater management, \*Groundwater quality, \*Rhode Island, \*Water resources development, \*Wood River Basin, Dissolved solids, Finite difference methods, Groundwater resources, Hydraulic head, Model studies, Nitrates, Pesticides, Well yield.

The 36 sq mi lower Wood River study area is located within the Pawcatuck River basin in southern Rhode Island. Stratified drift is the only princiern Rhode Island. Stratified drift is the only principal geologic unit capable of producing yields > 350 gallons per minute (gpm). The stratified drift aquifer consists of interbedded lenses of sand and gravel, with lesser amounts of silt, silty sand, and clay. Transmissivity of the aquifer ranges from 8,600 to 36,400 sq h/d. Water table conditions prevail in the aquifer, which is in good hydraulic connection with perennial streams and ponds. The chemical quality of groundwater in the study area is generally good to excellent and suitable for most uses. The water is soft, slightly acidic, and typically contains < 100 mg/L dissolved solids. Locally, however, groundwater has been contaminated with nitrate, pesticides, and radionuclides associated with various land use and waste disposal activities. Concentrations of Fe and Mn locally exceed Federal drinking water standards, but probably are derived from natural sources. A digital finite difference model of the groundwater flow system was ference model of the groundwater flow system was used to simulate the interaction between surface water and groundwater. Differences between computed model heads and measured heads in 33 observation wells were < 1.80 ft at 80% of the observation well-nodes. Total pumpage for selected development alternative simulations ranged from 6.0 to 11.0 mgd (million gallons per day). from 6.0 to 11.0 mgd (million gallons per day). Individual wells were pumped at constant rates of 1.0 mgd for all simulations. The areas most favorable for development of high capacity wells (350 gpm or more) are along the Wood River, Meadow Brook, Meadow Brook Pond, and the area around Ellis Flats. Thirty-six to 43% of the water withdrawn from wells will be derived from induced recharge from surface water sources. Development alternatives simulated in this study indicate that the alternatives simulated in this study indicate that the groundwater reservoir can sustain withdrawals of 6 to 9 mgd under long-term average annual hydrological conditions, without causing excessive streamflow depletion or decrease in aquifer saturated thickness. However, it may be necessary to reduce pumpage below 6.0 mgd to maintain some flow in Meadow Brook during drought periods. (Author's abstract) (Author's abstract) W91-11572

DESCRIPTION OF THE PHYSICAL ENVIRONMENT AND COAL-MINING HISTORY OF WEST-CENTRAL INDIANA, WITH EMPHASIS ON SIX SMALL WATERSHEDS. For primary bibliographic entry see Field 2E. W91-11576

POTENTIAL FOR AQUIFER RECHARGE IN ILLINOIS (APPROPRIATE RECHARGE AREAS).

Illinois State Geological Survey Div., Champaign. For primary bibliographic entry see Field 7C. W91-11580

HYDROLOGY OF THE ARBUCKLE MOUNTAINS AREA, SOUTH-CENTRAL OKLAHO-

MA. Geological Survey, Oklahoma City, OK. R. W. Fairchild, R. L. Hanson, and R. E. Davis. Oklahoma Geological Survey Circular 91, 1990. 112p, 29 fig, 20 tab, 42 ref, 8 append, 2 plates.

Descriptors: \*Arbuckle Mountains, \*Geohydro-logy, \*Groundwater resources, \*Karst, \*Oklaho-ma, Aquifers, Dissolved solids, Groundwater movement, Groundwater quality, Groundwater re-charge, Hydrologic budget, Surface-groundwater relations, Water level, Water quality.

Rocks that make up the Arbuckle-Simpson aquifer crop out over 500 sq mi in the Arbuckle Mountains province in south-central Oklahoma. The aquifer consists of limestone, dolomite, and sandstone of consists of limestone, dolomite, and sanostone of the Arbuckle and Simpson Groups of Lake Cam-brian to Middle Ordovician age and is 5,000-9,000 ft thick. The rocks were subjected to intensive folding and faulting associated with major uplift of the area during Early to Late Pennsylvanian time. the area during Early to Late remsylvaman time. Water in the aquifer is confined in some parts of the area, while in other parts it is unconfined. The average saturated thickness of the aquifer is 3,500 ft in the outcrop area. Water levels measured in

wells fluctuated from 8-53 ft each year, primarily in response to recharge from rainfall. Recharge to the aquifer is estimated at 4.7 in/yr. The average storage coefficient of the aquifer is estimated at 0.008, and the average transmissivity is estimated at 15,000 sq. ft/day. Based on an average saturated thickness of 3,500 ft and a storage coefficient of 0.008 the values of groundwater contained in the thickness of 3,500 it and a storage outcome.

0.008, the volume of groundwater contained in the

500 sq mi outcrop area is 9 million acre-ft. An

undetermined amount of fresh water probably

exists in the aquifer around the periphery of the aquifer outcrop. Base flow of streams that drain the aquifer accounts for 60% of the total annual the aquirer accounts for over of the total annual runoff from the outcrop area and is maintained by numerous springs. The close hydraulic connection between streams in the outcrop area and the aquirer is shown by a close correlation between base flow in Blue River and the fluctuation of ground-water leavels in the walls in the Blue River basin water levels in five wells in the Blue River basin. This correlation also exists between the discharge Inis correlation asso exists seleween the uschange by Byrds Mill Spring and the fluctuation in water level in a nearby observation well; increase and decrease in spring discharge correspond to a rise and fall of the water level in the well. The chemical quality of water from the Arbuckle-Simpson coulfer is withhele for most industrial and municipal. aquifer is suitable for most industrial and municipal uses. The water is hard and of the bicarbonate type; the average hardness is 340 mg/L, and the average dissolved solids concentration is 360 mg/ L. (Author's abstract) W91-11590

EVALUATION OF SITE-SELECTION CRITE-EVALUATION OF SITE-SELECTION CRITE-RIA, WELL DESIGN, MONITORING TECH-NIQUES, AND COST ANALYSIS FOR A GROUND-WATER SUPPLY IN PIEDMONT CRYSTALLINE ROCKS, NORTH CAROLINA. C. C. Daniel.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water Supply Paper 2341, 1990. 35p, 22 fig, 3 tab. 21 ref.

Descriptors: \*Cost-benefit analysis, \*Groundwater management, \*Groundwater quality, \*Groundwater resources, \*Monitoring, \*North Carolina, \*Pieder resources, 'Monitoring, 'North Carolina, 'Pret-mont Physiographic Province, 'Wells, Crystalline rocks, Economic aspects, Geohydrology, Model studies, Site selection, Statistics, Well yield.

A statistical analysis of data from wells drilled into A statistical analysis of data from well stitled into the crystalline rocks of the Piedmont and Blue Ridge provinces of North Carolina verified and refined previously proposed criteria for the siting of wells to obtain greater than average yields. An opportunity to test the criteria was provided by the expansion of the town of Cary's municipal ground-water system. Three criteria were used: (1) type of rock; (2) thickness of saturated regolith based upon topography; and (3) presence of fracture and joints topography; and of presence of nacture and Johns based upon drainage lineation. A conceptual model of the local geohydrologic system was developed to guide the selection of the most favorable well sites, and on the basis of the model, six type sites were determined. Eleven of the twelve test that were located on the basis of type sites yielded from slightly above average to as much as six times the average yield to be expected from particular rock types as reported in the literature. Only one well drilled at a type site had a less than average yield. One well not located at any of the type sites produced little water. Long-term testing and moniproduced little water. Long-term testing and mon-toring after the wells were put into production showed that an 18-hour-on, 6-hour-off pumping cycle was much more effective in terms of total production, reduced head loss, and less drawdown, then a 5-day-on and 2-day-off cycle. It was also observed that long-term yields by the production wells were about 75% of those predicted on the basis of 24-hour pumping tests and only about 60% of the driller's reported yields. Cost analysis abouted that he write criterio selected wall effect. showed that by using criteria selected well sites, a cost-effective well system can be developed that cost-effective well system can be developed that will provide water at an equivalent or lower cost than a surface water supply. The analysis showed that the system would be cost-effective if only one high yield well were obtained out of every four drilled. (Author's abstract)

#### Water In Soils—Group 2G

GROUND-WATER FLOW AND STREAM-AQ-UIFER RELATIONS IN THE NORTHERN COASTAL PLAIN OF GEORGIA AND ADJA-CENT PARTS OF ALABAMA AND SOUTH CAROLINA.

Geological Survey, Atlanta, GA. Water Resources

DIV.

R. E. Faye, and G. C. Mayer.

Available from Books and Open Files Reports
Section, USGS Box 25425, Denver, CO 80225.

USGS Water-Resources Investigations Report 884143, 1990. 83p, 11 fig, 19 tab, 96 ref, 4 maps.

Descriptors: \*Alabama, \*Aquifers, \*Geohydro-Descriptors: "Alabama, "Aquifers, "Geohydro-logy, "Georgia, "Groundwater movement, "South Carolina, "Surface-groundwater relations, Evapo-transpiration, Groundwater discharge, Ground-water recharge, Groundwater resources, Hydro-logic budget, Model studies, Water table.

Digital cross-section models, hydrograph separa-tion, and other analytical methods were used to describe groundwater flow and stream-aquifer redescribe groundwater flow and stream-aquiter re-lations for the clastic Coastal Plain aquifers of eastern Alabama, Georgia, and western South Carolina. Cross-section model simulations indicate that the spatial distribution of net recharge and discharge is highly variable and ranges from < 1.0 to about 20 inches/year. The water table configuto about 20 inches/year. The water table configu-ration largely determines the distribution of hy-draulic potential in cross-section at least to the top of the uppermost regional confining unit. Simulat-ed discharge to the largest rivers ranges from 7% to 17% of total net recharge, and represents flow along the longest flowpaths of a cross section. A hydrologic budget indicates that total mean annual aquifer recharge equals about 9,000 cu ft/sec. Of this quantity, 780 cu ft/sec is discharged from the regional flow regime to regional drains. 1,950 cu regional flow regime to regional drains, 1,950 cu ft/sec is discharged from the intermediate flow It/sec is discharged from the intermediate flow regime to streams tributary to regional drains near the point of recharge. Evapotranspiration occurs at a rate of 660 cu ft/sec. A subsurface flow of 310 cu ft/sec occurs downgradient from the study area and represents that component of recharge not discharged to any stream. (Author's abstract) W91-11598

#### 2G. Water In Soils

MACROALGAL-SEDIMENT NUTRIENT INTERACTIONS AND THEIR IMPORTANCE
TO MACROALGAL NUTRITION IN A EUTRO-

Western Australia Univ., Nedlands. Centre for

For primary bibliographic entry see Field 2L. W91-10497

MODELLING WATER AND SOLUTE TRANS-PORT IN MACROPOROUS SOIL, I. MODEL DESCRIPTION AND SENSITIVITY ANALYSIS. Sveriges Lantbruksuniversitet, Uppsala. Dept. of Soil Sciences.

For primary bibliographic entry see Field 5B. W91-10803

MODELLING WATER AND SOLUTE TRANS-PORT IN MACROPOROUS SOIL, II, CHLO-RIDE BREAKTHROUGH UNDER NON-STEADY FLOW.
Sveriges Lantbruksuniversitet, Uppsala. Dept. of Soil Sciences.

N. J. Jarvis, L. Bergstrom, and P. E. Dik. Journal of Soil Science JSSCAH, Vol. 42, No. 1, p 71-81, March 1991. 7 fig, 3 tab, 16 ref.

Descriptors: \*Chlorides, \*Model studies, \*Path of pollutants, \*Soil porosity, \*Soil water, \*Solutants, \*Soil porosity, \*Soil water, \*Solutantsport, \*Unsteady flow, Calibrations, Clays, Diffusion, Drip irrigation, Field tests, Hydraulic conductivity, Hydraulic properties, Leaching, Lysimeters, Model testing, Soil columns, Soil profiles,

A model of water and solute transport in macro-porous soils has been evaluated in column break-through experiments under field conditions. Hydraulic properties were first measured in replicate

soil monolith lysimeters sampled from grass pas-ture and continuous barley treatments in a clay soil. A pulse input of 0.05 M KCl was then sup-plied by drip irrigation and measurements made of the water discharge and chloride leaching resulting from the natural rainfall over a 1-month period. The results showed that the macropores constituted the dominant flow pathway (accounting for 80% of the total water outflow) and that diffusive exchange of chloride between the two flow do-mains was the main factor causing variability in leaching. Larger hydraulic conductivities and ma-croporosities in the lower topsoil and at plow depth in the grass pasture monoliths were taken as evidence of structural amelioration. Less of the applied chloride was leached in the grass mono-liths than in the barley (means of 20% and 31%, respectively). This was mostly due to a smaller effective aggregate size and thus a more efficient diffusion-controlled retention. (Author's abstract) (See also W91-10803)

SIMPLE DESIGN FOR SIMULTANEOUS STEADY-STATE INFILTRATION EXEMENTS WITH RING INFILTROMETERS.

California Univ., Berkeley. Dept. of Soil Science. For primary bibliographic entry see Field 7B.

SPATIAL AND TEMPORAL INFLUENCE OF SOIL FROST ON INFILTRATION AND EROSION OF SAGEBRUSH RANGELANDS, Agricultural Research Service, Boise, ID. North-west Watershed Research Center.

W. H. Blackburn, F. B. Pierson, and M. S. Sevfried.

Water Resources Bulletin WARBAQ, Vol. 26, No. 6, p 991-997, December 1990. 3 fig, 4 tab, 35 ref.

Descriptors: \*Erosion, \*Frozen soils, \*Infiltration, \*Runoff, \*Sagebrush, \*Soil erosion, \*Soil water, Infiltration capacity, Plant cover, Range grasses, Soil temperature, Statistical analysis, Vegetation

Soil infiltration capacity and interrill erosion are significantly influenced by soil frost on western rangelands which are characterized by cold win-ters and numerous freeze-thaw cycles. However, little is known about the variable influence of this phenomenon. Infiltration and interrill erosion were measured within a sagebrush-grass plant community during the winter, spring, and summer of 1989. Significant spatial and temporal differences in infiltration capacity were found for shrub coppice dune and dune interspace soils. Infiltration was generally higher for coppice dune soils compared to interspace soils throughout the year. Infiltration capacity for both soils was lowest early in the year when the soil was frozen or saturated, then increased as the soil dried in the spring and summer. Interrill erosion was consistently lower for coppice dune soils compared to interspace soils. Erosion dulie solis compared to interspace soils. Existing from interspace soils was greatest during a 19-day period in late winter characterized by diurnal freeze-thaw cycles, saturated surface soil conditions, and soil slaking. (Author's abstract) W91-10820

STUDIES ON THE ENVIRONMENTAL PER-SISTENCE OF S-31183 (PYRIPROXYFEN: AD-SORPTION ONTO ORGANIC MATTER AND POTENTIAL FOR LEACHING THROUGH

California Univ., Parlier. Mosquito Control Reearch Lab For primary bibliographic entry see Field 5B.

W91-10831

COMPARISON OF MEASURED AND ESTI-MATED UNSATURATED HYDRAULIC CON-DUCTIVITIES DURING SNOWMELT.

Trent Univ., Peterborough (Ontario). Watershed Ecosystems Program.
K. Sami, and J. M. Buttle.

Journal of Hydrology JHYDA7, Vol. 123, No. 3/ 4, p 243-259, March 1991. 5 fig, 4 tab, 38 ref.

Descriptors: \*Flow, \*Hydraulic conductivity, \*Infiltration, \*Snowmelt, \*Soil water, \*Unsaturated flow, Comparison studies, Drainage, Isotopic tracers, Recharge, Model studies, Pores, Saturated flow, Soil types

Estimates of unsaturated flow often require an assessment of the relationship between unsaturated hydraulic conductivity (Ku) and moisture content. ured Ku-moisture relationships for a well-Measured Ku-moisture relationships for a wein-sorted sandy soil were obtained using the instanta-neous profile method during snowmelt recharge. These values were compared with estimates from three approaches: the Campbell equation, a modi-fied version of the Campbell model that considers residual water, and the rate of isotopic tracer dis-placement during infiltration. The modified Camp-bell model provided the best fit to the observed although all three methods over-predicted Ku. The isotopic tracer method overestimated observed Ku values by 2.6-4.5 times. This may reflect served Ku values by 2.6-4.3 times. This may reflect the role of macropores upon hydraulic conductivities during infiltration, since the tracer method is employed during recharge, while the instantaneous profile method is generally used during drainage periods when macropores are nonconductive. Whereas Ku estimates derived from empirical approaches such as the Campbell model may be valid during conditions of drainage, the isotopic tracer ourning conditions of dramage, the isotopic tracer model appears to provide more realistic conductiv-ity values during infiltration. The isotopic tracer method also provides a direct means of estimating the immobile fraction of total soil water. (Author's abstract) W91-10904

SOIL WATER DYNAMICS RELATED TO WATERLOGGING IN A SLOPING CATCHMENT. Eastern Univ., Chenkaladi (Sri Lanka). Div. of Agricultural Engineering.
C. S. Atputhanathan, E. R. N. Gunawardena, and K. R. Rushton.

Journal of Hydrology JHYDA7, Vol. 123, No. 3/ 4, p 279-295, March 1991. 9 fig, 1 tab, 22 ref.

Descriptors: \*Slopes, \*Soil water, \*Waterlogging, \*Watersheds, Drainage, Flow, Flow pattern, Hy-draulic conductivity, Hydrologic budget, Irriga-tion, Mathematical models, Model studies, Water

A study to understand the factors contributing to waterlogging was conducted in a small catchment of 5.4 ha in an irrigation scheme in the Eastern Dry Zone of Sri Lanka. Extensive mean of groundwater heads, soil moisture profiles and other hydraulic properties were made with special emphasis on the waterlogged areas. An understanding of the importance of the lateral movement of water has been developed using a mathematical model which represents both lateral and vertical components of flow. The study demonstrated that standard techniques, such as an overall catchment water balance and SEW index (the index is the sum of excess water table elevations about a 30-cm or excess water table elevations about a 30-cm depth and expressed as cm-days), do not provide an adequate explanation of waterlogging in sloping lands with surface irregularities. The field results show that the waterlogging problem is spatially distributed, hence the averaging of parameters does not explain the observed results. The discrete space-discrete time finite difference model devel-oped for this study has successfully represented the oped for this study has successfully represented the complex nature of waterlogging and rapid drying. Important features include: variations in hydraulic conductivity with depth; variations in hydraulic conductivity along the profile; the limited distance affected by the drain; and the ponding of water on the soil surface. The agreement between the simulated and field results was satisfactory. (Agostine-PTT) PTT W91-10906

HYDROGEOCHEMICAL PROCESSES CONTROLLING SUBSURFACE TRANSPORT FROM AN UPPER SUBCATCHMENT OF WALKER BRANCH WATERSHED DURING STORM EVENTS. 2. SOLUTE TRANSPORT PROCESSES

Tennessee Univ., Knoxville. Dept. of Plant and

#### Group 2G-Water In Soils

Soil Science. For primary bibliographic entry see Field 5B. W91-10908

SELF-AFFINE SCALING AND SUBSURFACE RESPONSE TO SNOWMELT IN STEEP TER-

Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
C. J. Duffy, K. R. Cooley, N. Mock, and D. H.

Journal of Hydrology JHYDA7, Vol. 123, No. 3/ 4, p 395-414, March 1991. 15 fig, 23 ref. USDA Agricultural Research Service Cooperative Agreement 58-0401-7-00145.

Descriptors: \*Groundwater movement, \*Mathematical studies, \*Model studies, \*Runoff, \*Slopes, \*Snowmelt, \*Subsurface water, \*Sufface-groundwater relations, Base flow, Bedrock, Dynamics, Flow, Hysteresis, Permeability, Streams, Topogra-Watersbeds

The use of local scaling transformations is proposed as a framework for modeling the geometry and dynamic response of subsurface flow from steep hillslopes. The study site is the Upper Sheep Creek Watershed, a first-order sub-basin in the Reynolds Creek Experimental Watershed, southest Idaho. The purpose of the study was to gain insight into the evolution of snowmelt, subsurface flow, and runoff generation in this rugged volcanic terrain. In this phase of the study rescaling geometrically proportional (self-affine) surface and bedrock slope profiles provides an analytical framerically proportional (self-affine) surface and bed-rock slope profiles provides an analytical frame-work for defining the shape, volume and dynamic changes of saturated flow for this hillslope system. Rescaling self-affine hillslope trajectories along a stream reach, collapses the flow-domain to a unit cube. A dynamic model for hillslope runoff is proposed, and implications for modeling topo-craphic controls on the snowmelt process are sucgraphic controls on the snowmelt process are significant gested. An experimental relation between volu of water stored on the hillslope and baseflow from the stream reach, is shown to exhibit hysteretic behavior. The hysteresis is interpreted as resulting from heterogeneities of the hillslope permeability, and transient subsurface storage in the near-chan-nel region. (Author's abstract) W91-10912

CAUSES OF DEGRADATION OF CHEMICAL AND PHYSICAL PROPERTIES OF CHERNOZEMS IRRIGATED WITH NONMINERA-LIZED WATER.

Moscow State Univ. (USSR). Dept. of Soil Sci-

ence. F. R. Zaydelman, and I. Y. Davydova. Soviet Soil Science SSSCAE, Vol. 22, No. 4, p 11-19, 1990. 8 tab, 11 ref. Translated from Pochvovedeniye, No. 11, p 101-108, 1989.

Descriptors: \*Chemical properties, \*Irrigation effects, \*Physical properties, \*Soil properties, \*Soil ypes, Chernozems, Lysimeters, Soil compaction, Soil organic matter, Waterlogging.

A study was made of the effect of irrigation on the properties of the solid phase of an A-plow horizon of Typical Chernozem and on the composition of lysimeter waters using nonmineralized water at rates not exceeding the field capacity and causing short-term (5 hour) and prolonged (2 month) waterlogging. Short-term over-irrigation with fresh water in the presence of fermentable organic matter causes rapid degradation of these soils and their compaction. The cause of this phenomenon is their compaction. The cause of this phenomenon is due to the development of gleying under a periodically stagnant regime. It is accompanied by a sharp decrease in the redox potential of soils and their acidification, discharge into lysimeter waters of large amounts of iron and calcium, increase in humus mobility, narrowing of the C-HA/C-FA ratio and by a sharp decrease in permeability (by 1-2 orders of magnitude). Gley formation in Chernozems is the cause of their degradation where fresh water is to be used for irrigation. The major problem in the irrigation of Chernozems lies in the selection of measures which will preclude the desection of measures which will preclude the deselection of measures which will preclude the de-velopment of this soil-forming process. (Author's

W91-10913

EFFECT OF LONG-TERM APPLICATION OF FERTILIZERS ON THE AGROPHYSICAL PROPERTIES OF AN IRRIGATED LIGHT-

CHESTNUT SOIL.
All-Union Scientific Research Inst. of Irrigated
Agriculture, Volgograd (USSR).
T. A. Kretinina.

T. A. Kretinina. Soviet Soil Science SSSCAE, Vol. 22, No. 4, p 50-58, 1990. 4 tab, 19 ref. Translated from Pochvove-deniye, No. 9, p 44-51, 1989.

Descriptors: \*Agriculture, \*Chestnut soils, \*Fertil-izers, \*Irrigation effects, \*Physical properties, \*Soil types, Aeration, Aggregates, Calcareous soils, Clays, Dispersion coefficient, Nitrogen, Porosity.

The effect of long-term (12-year) fertilization of irrigated soil on its physical properties was studied. Studies were carried out in the arid zone of the Lower Volga region in an experimental six-field fodder-grain crop rotation. The soil of the experimental plot is a strongly calcareous Light-Chestnut clay loam. It was found that Light-Chestnut soil becomes finer textured under irrigation. The concept of clay in the above layer irregated by 7, 106. tent of clay in the plow layer increased by 7-10% during two crop rotations. A variable degree of during two crop rotations. A variable degree of fertilization had no effect on particle-size composition. Long-term application of increasing amounts of nitrogen fertilizers against a P60K60 background resulted, compared to the control, in an increase in the bulk density of the soil and in a decrease of its total porosity and aeration porosity, rate of CO2 liberation from the soil surface as well as of the content and water stability of agronomi-cally valuable aggregates. The dispersion coeffi-cient increased and the structure factor decreased. cient increased and the structure factor decreased. With application of average and large amounts of nitrogen fertilizers alone and in combination with manure, the unfavorable changes in the agrophysical properties of a Light-Chestnut soil are less pronounced. (Agostine-PTT) W91-10914

PHYSICAL PROPERTIES OF IRRIGATED CHERNOZEMS OF THE SOUTHERN UKRAINE. Odesskii Gosudarstvennyi Univ. (USSR).

S. P. Poznyak. Soviet Soil Science SSSCAE, Vol. 22, No. 4, p 67-74, 1990. 4 tab, 12 ref. Translated from Pochvove-deniye, No. 2, p 48-55, 1990.

Descriptors: \*Irrigation effects, \*Physical properties, \*Soil properties, \*Soil types, \*Ukraine, Aeration, Aggregates, Chernozems, Density, Particle size, Percolation, Porosity, Saline water, Soil profiles, Soil water, Sprinkler irrigation.

To investigate the changes in the physical condi-tions of Chernozems under irrigation, several phys-ical properties of Ukrainian soils in the Ingulets. Lower Dniester, and Tatarbunar (terrace plain and drainage divide plateau) irrigation systems, where low salinity waters are used, were studied. In the study region irrigation is performed by sprinkling, using DDA-100M equipment. The changes in physical properties within the above irrigation sys-tems were assessed by comparing the results of investigations made in 1971 on non-irrigated and irrigated soils with results obtained on irrigated soils in 1986. To elucidate the contribution of irrigation to changes in the physical properties of low salinity waters are used, were studied. In the irrigation to changes in the physical properties of Chernozems, a comparison was made between the particle-size and microaggregate composition, the density of the soil and its solid phase, its bulk density of the soil and its sond phase, its bulk density, the total porosity and aeration porosity, and water uptake and percolation. It was found that irrigation of Chernozems with low-salinity waters in the Ingulets, Lower Dniester and Tatarbunar systems degrades their physical, hydro-physical, and air-water properties and results in argillization and compaction. The direction, character, rate, and depth of these processes in the soil profile depend on the length of irrigation. (Agostine-PTT) W91-10915

SORPTION PROPERTIES AND MOISTURE HYSTERESIS OF SOILS.

Akademiya Nauk SSSR, Novosibirsk. Inst. of Soil Science and Agrochemistry. N. I. Chashchina.

Soviet Soil Science SSSCAE, Vol. 22, No. 4, p 87-95, 1990. 2 fig, 1 tab, 15 ref. Translated from Pochvovedeniye, No. 2, p 89-96, 1990.

Descriptors: \*Hysteresis, \*Physical properties, \*Soil properties, \*Soil water, \*Sorption, Adsorption, Chernozems, Chestnut soils, Desorption, Porosity, Soil types.

The sorption characteristics and thermodynamics of soil moisture in Chernozems and Chestnut Brown soils of the southern zone of West Siberia were studied, and the boundary between strongly and loosely bound water was identified. The water adsorption and desorption isotherms of Siberian soils were obtained by studying the energy equilibrium of the soil solution with the potential of the surrounding system, i.e., by the hydroscopic technique. To investigate hysteresis, the measurements were made both during removal of water from the soil sample and during addition of water to it. The data on six Siberian soils indicate that almost no moisture hysteresis occurs in the light loam and loamy sand soils. In addition, hysteresis is not always directly dependent on the specific surface area of the soil. It may be assumed that major factors in the occurrence of hysteresis are the surface quality of the soil particles (form, depth, and width of depressions on them) and the porosity of the soil, i.e., the factors that give rise to capil-lary condensation. This is also indicated by the fact that in most of the Siberian soils that were studied hysteresis began to appear only when the relative humidity of the air exceeded 0.352. (Agostine-W91-10916

SECONDARY SALINIZATION OF SOILS OF THE DNIESTER DELTA FLOODPLAIN.

Kiev State Univ. (USSR). Dept. of Geography. M. R. P. Fedorishchak, V. V. Tsar, and P. G. Shishchenko.

Soviet Soil Science SSSCAE, Vol. 22, No. 4, p 101-112, 1990. 1 fig, 4 tab, 15 ref. Translated from Pochvovedeniye, No. 9, p 86-96, 1989.

Descriptors: \*Deltas, \*Flood control, \*Flood Descriptors: "Detais, "Flood Control, "Flood rolling, "Flood Control, "Flood C

An increase in salinity of water as a consequence An increase in saimly of water as a consequence of reduced runoff is currently taking place in the Dnestrovskiy liman and estuary of the Dniester. A study of the salinization of Delta-Floodplain soils was conducted. The study included particle-size analysis of Delta-Floodplain soils, salinity measurements of the Dnestrovskiy liman, analysis of salt composition of soils and groundwater of the estua-rine portion of the floodplain and of the coasts of the Dnestrovskiy liman. It was found that intrusion of Black Sea waters into the Dnestrovskiy liman increased as a result of regulation of flow of the Dniester and progressive consumptive use of its waters by various branches of the national economy. This led to an increase in salinity not only of liman waters but also of groundwater of coastal areas, including the estuarine portion of the river valley. Under dry climate conditions in the steppe vaney. Oldet my Chinace conditions in the steppe zone an increase in mineralization of groundwater close to the surface leads to secondary salinization of Delta-Floodplain soils. Also contributing to an accumulation of salts in soils is the shorter duration of high water flows and floods, which significantly reduces their role in natural desalinization of soils. Secondary salinization of soils differs in various parts of the delta floodplain. The content of chlorine and sodium increases from the apex to the lower part of the delta. Highest salt accumulations occur predominantly in upper layers of the soils, which attests to the progressive character of the salinization. (Agostine-PTT) W91-10917

# Water In Soils—Group 2G

TRANSFORMATION OF (C-14)-2,4-DICHLOR-OPHENOL IN SASKATCHEWAN SOILS, Agriculture Canada, Regina (Saskatchewan). Re-For primary bibliographic entry see Field 5B. W91-10922

NUMERICAL MODELLING OF VERTICAL GROUND MOVEMENTS IN EXPANSIVE

Saskatchewan Univ., Saskatoon. Dept. of Civil Engineering. P. J. Sattler, and D. J. Fredlund.

Canadian Geotechnical Journal CGJOAH, Vol. 28, No. 2, p 189-199, April 1991. 18 fig, 20 ref.

Descriptors: \*Expansive soils, \*Mathematical models, \*Numerical analysis, \*Soil engineering, \*Soil water, Groundwater movement, Infiltration, Permeability, Soil moisture retention, Soil proper-

Geotechnical engineers throughout the world are familiar with the challenges posed by expansive soils; vertical ground movements associated with expansive soil deposits cause more damage to light engineered structures than all other natural disasters combined. A numerical model was developed to salvie matric suction changes and vertical ters comoined. A numerical model was developed to relate matric suction changes and vertical ground movements. The research considers one-dimensional vertical ground movements under open-vegetated fields subject to changing climatic conditions. A percentage of the Thornthwaite potential evapotranspiration model proved to be adequate to characterize the surface flux boundary quate to characterize the surface flux boundary condition. The infiltration and exfiltration processes were modeled separately for the field conditions. During infiltration, shrinkage cracks and the macrostructure of the soils dominate behavior. During this process, bulk permeabilities in the order of 0.000001 to 0.0000001 m's were required to simulate measured ground movements. Exfiltration processes are dominated by flow in the vapor phase as drying occurs in the soil. Bulk permeabilities in the order of 0.000000001 to 0.00000000001 m/s were required to simulate the measured m/s were required to simulate the measured ground movement. The simulations of ground movements would also indicate that thermally induced suctions (i.e. winter freezing conditions) could account for a significant portion of the seasonal vertical ground movements. The numerical model can also be used to predict seasonal ground movements beneath light engineered structures. Further research, however, is required to better understand how to establish the surface flux boundary condition. There is also a need for more case histories to enlarge the database of unsaturat-ed soil parameters. (Author's abstract) W91-10945

DYNAMIC SIMULATION MODEL OF VERTI-CAL INFILTRATION OF WATER IN SOIL. Gosudarstvennyi Gidrologicheskii Inst., Leningrad

For primary bibliographic entry see Field 2A. W91-10968

THROUGHFLOW AND SOLUTE TRANSPORT IN AN ISOLATED SLOPING SOIL BLOCK IN A FORESTED CATCHMENT.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.

G. M. Hornberger, P. F. Germann, and K. J.

Journal of Hydrology JHYDA7, Vol. 124, No. 1/ 2, p 81-99, April 1991. 8 fig, 3 tab, 33 ref. U.S. Environmental Protection Agency Agreement CR813575-01-0.

Descriptors: \*Forest hydrology, \*Forest soils, \*Geochemistry, \*Groundwater movement, \*Rain-fall-runoff relationships, \*Soil water, \*Soilut transport, Base flow, Flow pattern, Forest watersheds, Groundwater runoff, Hydrographs, Maine, Soil solution, Soil tests, Storm runoff, Streamflow, Sub-

The processes, flow paths, and residence times associated with subsurface flow are critically important in the interpretation of hydrochemical re-

sponses in steep, forested, upland catchments in humid temperate climates, where subsurface flow contributes a large portion of stormflow, as well as base flow, occurring in streams. A 3-m wide by 9-m long by 1-m deep soil block on a forested hillslope near Orono, Maine, was isolated by excavation of encircling trenches. A sprinkler system for application of water and potassium bromide tracer was constructed over the pick. Outflow was for application of water and potassium bromine tracer was constructed over the plot. Outflow was collected at six locations with troughs. Experi-ments were conducted at application rates of 2.5, 5, and 10 cm/h. Pulses of tracer were applied subse-quent to attainment of steady flow and breakand 10 cm/h. ruises of tracer were applied succeptured to attainment of steady flow and breakthrough curves were measured at all outflow points. Recession limbs of outflow hydrographs exhibited distinct breaks when plotted on semilogarithmic axes, indicating drainage from at least two distinguishable pore size classes or flow pathways. Solute breakthrough curves were dominated by a single peak; travel times of solute were inversely related to the application rate. A secondary peak in the outflow curve, which is consistent with transport theories for a homogeneous soil, was observed in all cases. This second peak is unexalained, but is conceptually consistent with the observed in all cases. Inis second peak is unex-plained, but is conceptually consistent with the notion of transport in at least two pore size classes. An undisturbed soil core (diameter of 30 cm and length of 40 cm) was sprinkled at the same rates as was the soil block, using Methylene Blue as tracer in the last run. Drainage hydrographs and visual examination of dye stains in the block indicated examination or dye stains in the block indicated also at this smaller scale that flow and transport are controlled by preferred paths in the soil, paths that cannot be morphologically distinguished from the surrounding soil matrix. Theoretical explanations of processes on such hillslopes need to account for this fact. (Author's abstract)

HYDROLOGIC, METEOROLOGICAL, AND UNSATURATED-ZONE MOISTURE-CONTENT DATA, FRANKING LAKE PLAYA, INYO ODATA, FRANKING LARE
COUNTY, CALIFORNIA.
Geological Survey, Denver, CO. Water Resources
County see Field 2F.

For primary bibliographic entry see Field 2F. W91-11089

SOIL SURVEY INFORMATION SYSTEM: A USER FRIENDLY SOIL INFORMATION SYSTEM.

For primary bibliographic entry see Field 7C. W91-11174

BIODEGRADATION OF HYDROCARBON VAPORS IN THE UNSATURATED ZONE.
Massachusetts Univ., Amherst. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W91-11227

KINETICS OF CHEMICAL WEATHERING IN B HORIZON SPODOSOL FRACTION.

Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.

For primary bibliographic entry see Field 5C.

W91-11233

IMPROVED ANALYSIS OF GRAVITY DRAINAGE EXPERIMENTS FOR ESTIMATING UNSATURATED SOIL HYDRAULIC FUNCTIONS. J. B. Sisson, and M. T. van Genuchten. Water Resources Research WRERAQ, Vol. 27, No. 4, p 569-575, April 1991. 3 fig, 2 tab, 26 ref.

Descriptors: \*Gravity drainage, \*Hydraulic conductivity, \*Soil water, \*Unsaturated flow, Data processing, Differencing, Drainage, Infiltration, Performance evaluation.

Unsaturated hydraulic properties are important parameters in any quantitative description of water and solute transport in partially saturated soils. Most in situ methods for estimating the unsaturated hydraulic conductivity (K) are based on analyses that require estimates of the soil water flux and the pressure head (h) gradient. These analyses typical-

ly involve differencing of field-measured pressure head (h) and volumetric water content (theta, th) data, a process that can significantly amplify instrumental and measurement errors. More reliable methods result when differencing of field data can be avoided. One such method is based on estimates of gravity drainage curve K'(th) = dK/dth, which may be computed from observations of th and/or h during the drainage phase of infiltration drainage experiments assuming unit gradient hydraulic conditions. The present study compared estimates of unsaturated soil hydraulic functions on the basis of different combinations of field data th, h, K, and K'. Five different data sets were used: (1) th-h, (2) K-th, (3) K'=th, (4) K-th-h, and (5) K'-th-h. The analysis was applied to previously published data for the Norfolk, Toup, and Bethany soils. The K-th-h and K'-th-h data sets consistently produced nearly identical estimates of the hydraulic functions. The K-th-h and K'-th data also resulted in similar curves, but results were less consistent than tions. The A-th and A-th data and resulted in similar curves, but results were less consistent than those produced by K-th-h and K-th-h data sets. These results demonstrate that differencing of field data can be avoided and that there is no need to data can be avoided and that there is no need to calculate soil water fluxes and pressure head gradi-ents from inherently noisy field-measured th and h data. The gravity drainage analysis also provides results over a much broader range of hydraulic conductivity values than is possible with the more standard instantaneous profile analysis, especially when augmented with independently measured soil water retention data. (Author's abstract) W91.1123.

MULTIMETHOD FOR PESTICIDES IN SOIL AT TRACE LEVEL.

ESWE-Inst. fuer Wasserforschung und Wassertechnologie G.m.b.H., Wiesbaden (Germany, For primary bibliographic entry see Field 5A. W91-11309

DETERMINATION OF HERBICIDE RESIDUES IN SOIL IN THE PRESENCE OF PERSISTENT ORGANOCHLORINE INSECTI-CIDES

Plant Protection Inst., Sofia (Bulgaria). For primary bibliographic entry see Field 5A. W91-11310

SIMPLE SPECTROPHOTOMETRIC DETERMINATION OF ENDOSULFAN IN RIVER WATER AND SOIL.

Ravishankar Univ., Raipur (India). Dept. of Chem-For primary bibliographic entry see Field 5A. W91-11314

SOIL CLEAN UP BY IN-SITU AERATION: VI. EFFECTS OF VARIABLE PERMEABILITIES. Malaga Univ. (Spain). Dept. de Ingenieria Qui-

For primary bibliographic entry see Field 5G. W91-11317

HYDROLOGICAL CONSEQUENCES OF ARTI-FICIAL DRAINAGE OF GRASSLAND.

Ministry of Agriculture, Fisheries and Food, Cambridge (England). Field Drainage Experimental

A. C. Armstrong, and E. A. Garwood. Hydrological Processes HYPRE3, Vol. 5, No. 2, p 157-174, April/June 1991. 9 fig, 7 tab, 33 ref,

Descriptors: \*Drainage, \*Grasslands, \*Soil water, \*Surface runoff, \*Waterlogging, Flood peak, Rainfall infiltration, Soil porosity, Water loss, Water

Water in the soil is a major factor affecting the growth and utilization of grass in agricultural systems. Although grass requires adequate supplies of water to maintain its growth, excess water will retard growth by waterlogging of the roots. Consequently, artificial drainage offers the potential for improving the productivity of grassland by in-

#### Group 2G-Water In Soils

creasing the grass yield and the length of the grazing season. Soil water regimes and water balances were evaluated for a series of drained and undrained experimental grassland plots to examine the agronomic consequences of drainage. Although drainage has lowered the water tables and reduced the duration of waterlogging in the drained plots, its effects in terms either of the total water quantities leaving the site or of peak flows is drained piots, its erfects in terms either of the total water quantities leaving the site or of peak flows is quite small. The major effect of drainage is to alter the route of water leaving the site. In its undrained state, the soil is waterlogged for the majority of the winter, incident rainfall cannot infiltrate, and water as surface runoff or near-surface flow. However, the introduction of fissures by mole drainage ever, the introduction of fissures by mole drainage both provides an outlet and enhances the macro-porosity, so that the rain moves rapidly through the soil and appears as drainflow. Consequently, the additional delay in generating peak runoff through the drainage system is only of the order of 30 minutes on the experimental plots. (Korn-PTT) W91-11347

SOIL MOISTURE: EMPIRICAL DATA AND MODEL RESULTS.

Gosudarstvennyi Gidrologicheskii Inst., Leningrad

Gosudarstvennyi Gudruogiciesan Man, Louisan, USSR).
K. Y. Vinnikov, and I. B. Yeserkepova.
Journal of Climate JLCLEL, Vol. 4, No. 1, p 66-79, January 1991. 7 fig, 3 tab, 18 ref. NOAA Grant NA90AADAC804.

Descriptors: \*Annual precipitation, \*Climatic data, \*Mathematical models, \*Model studies, \*Soil water, \*USSR, Data interpretation, Evapotranspiration, Global warming, Markov process, Regional analysis. Seasonal variation.

A large number of soil moisture measurements have been compiled from an observations network in the USSR. These data can be used to test parameterizations of hydrological processes employed in climate models. Soil moisture simulations for the current climate from general circulation models (GCMs) are not adequately realistic, making it difficult to accept mode-based conclusions of possible changes of soil moisture induced by anthropogenic global warming. Measurements for the period 1972-1985 give rather large values for the linear trend of soil moisture in the upper 1-m soil layer. The seasonal pattern of soil moisture does not correspond to the summer desiccation of continents scenario. Empirical data sets were found to confirm previously tested theoretical conclusions which stated that the spectrum of tempo-A large number of soil moisture measurements clusions which stated that the spectrum of temporal variations of soil moisture correspond to a fistorder Markov process with the decay time scale being equal to the ratio of field capacity to poten-tial evaporation. (Medina-PTT) W91-11413

SOLUTION IN CLOSED FORM AND A SERIES SOLUTION TO REPLACE THE TABLES FOR THE THICKNESS OF THE EQUIVALENT LAYER IN HOOGHOUDT'S DRAIN SPACING

LAYER IN HOOGHOUDI'S DRAIN SPACING FORMULA. Agricultural Univ., Wageningen (Netherlands). W. H. van der Molen, and J. Wesseling. Agricultural Water Management AWMADF, Vol. 19, No. 1, p. 1-16, January 1991. 3 fig, 2 tab, 13 ref, 7 appeared.

Descriptors: \*Computer models, \*Computers, \*Drain spacing, \*Drainage engineering, \*Flow models, \*Soil water, \*Subsoil drainage, Dagans formulat, Hooghoudts formula, Mathematical

The steady-state drainage equation of Hooghoudt is extensively used to find drain spacings, but it has the drawback that tables for the determination of the so-called 'equivalent layer, d' are needed. These tables were based on numerical approxima-tions, and nomographs were extensively used for name of age, where read-nomography an obsolete art, these methods have lost their appeal. A solution in closed form involv-ing theta-functions and a series solution to design purposes. In the computer age, where read-ing of tables has become a difficult operation and the tables for the thickness of the equivalent layer in Hooghoudt's drain spacing formula are presented. A series solution is far better suited for electronic computations; however, for thin aquifers their convergency is slow. In this case Dagan's formula is very accurate. A combination of both types of solutions provides an efficient algorithm. (Feder-PTT) W91-11430

EFFECT OF LOW SALINITY WATER ON SALT DISPLACEMENT IN TWO SOILS.

DISPLACEMENT IN TWO SOILS. Cairo Univ., Giza (Egypt). Faculty of Agriculture. A. M. Helalia, S. El Amir, A. A. Wahdan, and M. E. Shawky. Agricultural Water Management AWMADF, Vol. 19, No. 1, p 43-50, January 1991. 4 fig. 2 tab, 15 ref.

Descriptors: \*Conductivity, \*Hydraulic conductivity, \*Irrigation water, \*Saline soils, \*Salinity, \*Soil dynamics, Electrolytes, Leaching, Loam, Sand, Sodium, Soil chemistry, Soil physics, Soil texture.

Two soils, sandy and sandy loam, were leached with four displacing solutions in a laboratory experiment. The initial salinity of the saturation extract was 8.0 and 8.4 dS/m for the sandy and sandy loam soil, respectively. The electrical conductivity (EC) of the synthesized solutions (NaCl + CaCl2) was 2.1, 1.4, and 0.55 dS/m at sodium adsorption ratio (SAR) equal to 5, whereas the fourth solution (0.1 dS/I) consisted of distilled water. The solutions were used in sequence from high to low EC. The total volume of leachate with the sandy soil was about 44 pore volumes (PV), compared to about 21 PV with sandy loam soil in order to reach an equilibrium with the lowest EC solution used. an equilibrium with the lowest EC solution used. The time required for that equilibrium was 7.3 and 668.5 hours for the sandy loam soil, respectively. The lower hydraulic conductivity (K) and the long time required to equilibrate the sandy and sandy loam soil with low salt solution increased the leaching efficiency due to the complete mixing het many the displaced solution. between the displacing and displaced solution before displacement occurs. The high K and the short time needed to equilibrate the sandy soil caused partial mixing between the solutions and decreased partial mixing between the solutions and decreased the leaching efficiency. In both soils the low salinity water reduced the water movement and it took a large volume of water to lower the EC of leachate to a certain level. Therefore, the use of low salinity water for irrigation should be handled with care. (Author's abstract)

PRODUCTION FUNCTIONS RELATING CROP YIELD, WATER QUALITY AND QUANTITY, SOIL SALINTIY AND DRAINAGE VOLUME. California Univ., Riverside. Dept. of Soil and Environmental Sciences.

For primary bibliographic entry see Field 3C. W91-11434

LEAD SORPTION IN CALCAREOUS SOILS. Alexandria Univ. (Egypt). Dept. of Soil and Water Services.

For primary bibliographic entry see Field 5B. W91-11453

INFLUENCE OF FLOODED SOIL ON CHEMICAL COMPOSITION OF ANNUAL RYEGRASS AND DIGESTIBILITY BY MEADOW VOLES. Massey Univ., Palmerston North (New Zealand). For primary bibliographic entry see Field 2I. W91-11536

CAN FAUNA IMPOVERISHMENT AFFECT HUMUS CONTENT IN CULTIVATED SOILS (CZY UBOZENIE FAUNY MOZE WPLYWAC NA ZAWARTOSC PROCHNICY W GLEBACH

Polish Academy of Sciences, Lomianki. Inst. Ekologii. A. Kajak.

Wiadomosci Ekologiczne WEKLAF, Vol. 35, No. 3/4, p 235-249, 1989. 2 fig, 4 tab, 47 ref. English

Descriptors: \*Cultivation, \*Decomposing organic matter, \*Ecological effects, \*Soil organic matter,

\*Soil organisms, Biomass, Fertility, Food chains, Meadows, Mineralization, Species composition.

Studies were undertaken to demonstrate that changes in the humus content of soil are usually associated with changes in the number and biomass of soil fauna. Ecosystem disturbances such as cultior son rauna. Ecosystem disturbances such as culti-vation, clear-cutting, or swamp damage, are fol-lowed by a decrease in the content of organic matter and the number of animals in soil. More-over, the highest rate of humus decrement is assoover, the highest rate of numus decrement is asso-ciated with the greatest decrease in soil fauna. The decrease in organic matter involves not only a reduction of animal biomass, but also deep changes in the structure of animal communities. Size and individual weight decrease, while the trophic structure is transformed towards higher proporstructure is transformed towards higher propor-tions of herbivores and saprophages, which stimu-late the mineralization of organic matter. At the same time, species diversity diminishes. Long-term data from meadows and arable fields showed a positive correlation between humus content and biomass of soil fauna. However, although the data biomass of soil fauna. However, although the data indicate that fauna biomass and humus content are closely interrelated, they do not indicate the mechanism by which soil fauna affects humus. Results show that, if the decomposition of organic matter takes place under similar habitat conditions, then more humus is formed in the site rich in soil fauna may be concluded that agricultural treatments that pauperize the soil fauna simulta-neously cause a decrease in the organic matter content in soil, adversely affecting one of the cru-cial factors in soil fertility. (Author's abstract) W91-11543

PIPING AND PSEUDOKARST IN DRYLANDS. For primary bibliographic entry see Field 2F. W91-11561

#### 2H. Lakes

POTENTIAL IMPACTS OF CHANGE ON THE GREAT LAKES. OF CLIMATE

Environmental Protection Agency, Washington, DC. Office of Policy, Planning and Evaluation. J. B. Smith

Bulletin of the American Meteorological Society BAMIAT, Vol. 72, No. 1, p 21-28, January 1991. 3 fig, 3 tab, 32 ref.

Descriptors: \*Carbon dioxide, \*Climate changes, \*Global warming, \*Great Lakes, \*Lakes, Environmental effects, Ice cover, Lake management, Political aspects, Productivity, Shipping.

Global climate change could have a significant impact on the Great Lakes. A number of studies of the potential effects of climate change on the Great the potential effects of climate change on the Great Lakes were commissioned by the U.S. Environ-mental Protection Agency, using common scenar-ios of global warming derived mainly from general circulation models. These studies found that a dou-bling of carbon dioxide concentrations in the at-mosphere could eventually lower Great Lakes water levels by 0.5 to 2.5 m; reduce ice cover by 1 to 2.5 months: lengthen shipping, seasons while to 2.5 months; lengthen shipping seasons while increasing shipping and dredging costs; reduce dissolved oxygen levels in shallow lake basins; and increase fish productivity. Measures should be taken in the near future to anticipate many of these impacts and mitigate their effects or avoid costly political issues. (Author's abstract) W91-10480

PERSPECTIVES FOR ECOLOGICAL MODEL-LING OF TROPICAL AND SUBTROPICAL RESERVOIRS IN SOUTH AMERICA.

Sao Paulo Univ., Sao Carlos (Brazil). Escola de

Ball Faul China, Sal Calland, S

Descriptors: \*Model studies, \*Reservoirs, \*South America, \*Subtropic zone, \*Tropical regions, Computer models, Dissolved oxygen, Eutrophica-tion, Hydrologic cycle, Morphometry, Rain for-ests, Seasonal variation.

Lakes-Group 2H

Basic characteristics of tropical and subtropical reservoirs in South America examined. The baseline environment is considered the reservoir area and the hydrographic basin, including the region downstream. For the modelling effort it is neces-sary to establish a conceptual framework based on downstream: a conceptual framework based on the following characteristics: morphometry and compartments, retention time; hydrological cycle and flow requirements; reservoir; reservoir thermal stratification and circulation patterns; quantification of submerged forest biomass and its degradation in reservoirs located in the tropical rainforest; discalled avoyage consumption: potential for cudissolved-oxygen consumption; potential for eu-trophication and loading capacity; pulses in forcing functions; and suspended-material transport. In the tunctions; and suspended-material transport. In the region downstream it is necessary to consider river recovery capacity, water uses and flow regime requirements. Most reservoirs in this latitudinal gradient follow a significantly different path from the reservoirs in temperate zones, including effects of forcing functions, decomposition rates, and seasonal circulation periods. The size, volume and dimension of these large artificial ecosystems, justify the implementation of several methodological approaches useful for modelling. including oceanoapproaches useful for modelling, including oceano-graphic techniques and intensive use of satellite images. Rates of processes in tropical ecosystems are not well known, and such input from experi-mental limnology will be an important step as a basis for the modelling effort. The organization of basis for the modeling entort. The organization of a data bank for these reservoirs is in progress, and such a system is also fundamental for the modelling procedure. The modelling effort for tropical reservoirs is mainly due to the need for evaluation of effects, prediction of eutrophication, prognosis for possible deterioration of water quality in reservoirs with inundated forest, and introduction of management techniques for multiple uses including upstream/downstream environments. Management techniques include exploitation of spatial heteroge-neity, regulation of retention time and optimal biomass. (Author's abstract) W91-10487

FEATURES OF THE LIMNOLOGICAL BE-HAVIOR OF SALTO GRANDE'S RESERVOIR (ARGENTINA-URUGUAY).
DECISION S.R.L., Buenos Aires (Argentina).
For primary bibliographic entry see Field 5C.
W91-10491

ORGANIZATION OF THE DYNAMIC NETWORK STRUCTURE IN THE DIMENSION OF

Eidgenoessische Technische Hochschule, Zurich (Switzerland). Biological Reaction Engineering Group. C. Pahl-Wostl.

Ecological Modelling ECMODT, Vol. 52, No. 1/2, p 115-123, November 1990. 5 fig, 10 ref.

Descriptors: \*Ecosystems, \*Energy transfer, \*Mathematical models, \*Model studies, Ascendency, Computers.

Ecosystems can be described as networks of flows Ecosystems can be described as networks of flows of material and energy. A measure to quantify the growth and development of an ecosystem is systems ascendency. Growth is represented by the increase in total system throughput and development by the increase in the average mutual information of the network structure. To incorporate temporal dynamics into the systems ascendency, the static invocidimensional flow network is extemporal dynamics into the systems ascendency, the static two-dimensional flow network is extended into a third dimension—that of time. System ascendency is now calculated, using time-varying probabilities, resulting in what is called time-dependent ascendency. The time-dependent ascendency is a sensitive measure for the organization of the dynamic network structure in the dimension of the dyn time. This is demonstrated by using a simple two-level ecosystem model. Optimization of the timedependent ascendency is suggested as a selection criterion for the succession of species in the seasonal cycle. Especially in the aquatic environment, where environmental and biological variability are of utmost importance, a new perspective from the viewpoint of a dynamic network structure could provide new insights into general laws of ecosys-tem function. (Author's abstract) W91-10492

FIRST-ORDER ORGANIC CARBON BUDGET IN THE ST LAWRENCE LOWER ESTUARY FROM 13C DATA.

Quebec Univ., Montreal. For primary bibliographic entry see Field 2L. W91-10498

EASTERN MEDITERRANEAN: A MARINE DESERT.

Centre for Research in Environmental and Water Resources Engineering, Haifa (Israel).

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 225-232, 1991. 3 fig, 4 tab, 24 ref.

Descriptors: \*Aswan Dam, \*Coastal areas, \*Israel, \*Mediterranean Sea, \*Nutrient concentrations, \*Oligotrophy, \*Primary productivity, Chlorophyll, Continental shelf, Dam effects, Fish, Fisheries, Pelagic waters, Species diversity.

The Mediterranean Sea is considered by many as one of the less productive seas of the world. Due to geophysical and arid climatic conditions, the eastern Mediterranean is the most oligotrophic part of the sea. After the opening of the Aswan Dam in 1965, the major nutrient contribution to the Medi-terranean was considerably diminished. Several cruises and laboratory studies of the pelagic waters off the Israel shore indicated that the eastern Mediterranean is comparable with the most oligotrophic parts of open oceans. The neritic waters, overlying the narrow continental shelf (10 to 20 km), were the narrow continental shelf (10 to 20 km), were much more productive than the pelagic waters, having on average three times the chlorophyll concentration and five times the primary production of the pelagic waters. However, even the neritic zone is very unproductive as compared to similar regions of the world. The total catch of marine fishes, not surprisingly, along the Israeli coast is only a few thousand tons annually. (Author's abstract) thor's abstract) W91-10553

SPECIES COMPOSITION OF FISH COMMUNITIES IN NORTHERN WISCONSIN LAKES: RELATION TO PH.

National Fisheries Research Center, La Crosse, WI.

For primary bibliographic entry see Field 5C.

LAKE LANSING DREDGING EVALUATION

STUDY, 1978-1984.
Michigan Dept. of Natural Resources, Lansing.
For primary bibliographic entry see Field 5G.
W91-10748

FATE OF SILICATE MINERALS IN A PEAT

BOG. Texas Univ. at Austin. Dept. of Geological Sci-P. C. Bennett, D. I. Siegel, B. M. Hill, and P. H.

Glaser.
Geology GLGYBA, Vol. 19, No. 4, p 328-331, April 1991. 3 fig. 1 tab, 22 ref. American Chemical Society Petroleum Research Fund No. ACSPRF 19582-AC2.

Descriptors: \*Peat bogs, \*Silica, \*Silicates, \*Water chemistry, \*Wetlands, Chemical interactions, Chemical reactions, Coal, Cores, Diatoms, Equilibrium, Geohydrology, Hydrogen ion concentration, Interstitial water, Minnesota, Organic acids, Peat, Piezometers, Quartz, Silicon, Solubility.

Pore waters in marine and lacustrine sediments often contain dissolved silicon well in excess of the onen contain dissolved silicon well in excess of the equilibrium solubility of quartz. The source of that silicon is often presumed to be from dissolving amorphous silica, or from soluble silicate minerals. However, in some organic-rich environments, quartz solubility is unusually high. An investiga-tion was undertaken to study the sort under the quartz solubility is unusually high. An investiga-tion was undertaken to study the pore water chem-istry, solid phase chemistry, and silicate-silt surface textures for a peatland in northern Minnesota. The results of the study revealed that quartz and alu-minosilicates rapidly dissolve in anoxic, organic-rich, neutral-pH environments. In the peat bog,

normally a recharge mound, dissolved silicon in-creases with depth as pH increases, exceeding the creases with depth as pri increases, exceeding the background silicon concentration by a factor of two. Silicate grain surfaces, including quartz, are chemically etched at this location, despite being in contact with pore water at neutral pH with dissolved silicon well above the equilibrium solubility of quartz. The increasing silica concentrations at of quartz. The increasing silica concentrations at circum-neutral pH are consistent with a system where silicate solubility is influenced by silica-organic acid complexes. Silica-organic acid complexes, therefore, may be the cause of the almost complete absence of diatoms in decomposed peat and contribute to the formation of silica-depleted underclays commonly found beneath coal. (Korn-W91-10789

ITERATIVE EVALUATION OF A LAKE WATER QUALITY MANAGEMENT PRO-WATER GRAM,

Cassandra Consulting Co., Kenoza Lake, NY For primary bibliographic entry see Field 5G. W91-10808

MACROPHYTE STANDING CROP AND PRIMARY PRODUCTIVITY IN SOME FLORIDA SPRING-RUNS.

Consejo Superior de Investigaciones Científicas, Gerona (Spain). Centro de Estudios Avanzados de

For primary bibliographic entry see Field 2E.

PRIMARY PRODUCTIVITY AND PLANKTON COMMUNITIES IN A TWO-RESERVOIR SERIES,

Polytechnic Inst., Trov. NY. Rensse laer Fresh Water Inst. J. Melcher, and M. J. Sebetich

Water Resources Bulletin WARBAQ, Vol. 26, No. 6, p 949-958, December 1990. 6 fig, 4 tab, 24 ref.

Descriptors: \*Ecosystems, \*Lake ecology, \*Lim-nology, \*Plankton, \*Primary productivity, \*Reser-voirs, \*Trophic level, Chlorophyll a, Dissolved oxygen, Monksville Reservoir, Phytoplankton, Thermal stratification, Zooplankton.

It is suggested that new impoundments undergo an initial period of trophic upsurge lasting one to three years because of organic detritus and inor-ganic nutrients from the inundated basin. The new Monksville Reservoir in Passaic County, New Monksville Reservoir in Passaic County, New Jersey, provided an opportunity to study the accelerated transformation of the Wanaque River into a 200-ha lake and to compare productivity with the older Wanaque Reservoir located immediately downstream. A one-year investigation of both reservoirs was conducted during 1988. The primary productivity (0.547 g C/sq m/d) of the new Monksville Reservoir was not significantly different from that of the established Wanaque Reservoir (0.668 g C/sq m/d). Mean surface chlorophyll a concentrations were similar (3.0-4.0 micrograms/L), although the Monksville Reservoir cathibited more pronounced chlorophyll peaks in spring and L), although the Monksville Reservoir exhibited more pronounced chlorophyll peaks in spring and late autumn. Phytoplankton and 200plankton populations were consistently larger and fluctuated sharply in the Monksville Reservoir. Both reservoirs became thermally stratified, but only the Monksville Reservoir developed a metalimnetic dissolved oxygen minimum. The results demonstrated that the predicted trophic upsurge in the new reservoir did not occur in the first year. Therefore, the ecosystem dynamics did not fit the model for larger reservoirs. (Author's abstract) W91-10815

POTENTIAL EFFECTS OF GLOBAL WARM-ING ON THE PRIMARY PRODUCTIVITY OF A SUBALPINE LAKE. CH2M/Hill, Sacramento, CA.

CH2M/Hill, Sacramento, CA.

E. R. Byron, and C. R. Goldman.

Water Resources Bulletin WARBAQ, Vol. 26, No. 6, p 983-989, December 1990. 5 fig. 23 ref. U. S.

Environmental Protection Agency Grant CR-814581-01-0 and National Science Foundation

#### Group 2H-Lakes

Grant BSR 87-05170.

Descriptors: \*Climatic changes, \*Climatology, \*Global warming, \*Limnology, \*Model studies, \*Mountain lakes, \*Primary productivity, Algal growth, Atmospheric circulation, California, Carbon dioxide, Castle Lake, Data collections, General circulation models, Greenhouse effect, Ice breakup, Precipitation, Prediction, Regression analysis. Snow denth. analysis, Snow depth.

Atmospheric scientists have predicted that large-scale climatic changes will result from increasing levels of tropospheric CO2. The potential effects of climate change on primary productivity has been investigated in Castle Lake, a mountain lake been investigated in Castle Lake, a mountain lake in Northern California. Annual algal productivity was modeled empirically using 25 years of limnological data in order to establish predictive relationships between productivity and the climatic variables of accumulated snow depth and precipitation. The outputs of monthly temperature and precipitation from three general circulation models (GCMs) of doubled atmospheric CQ2 were then used in the tion from time general circulation modes (GCMS) of doubled atmospheric CO2 were then used in the regression model to predict annual algal productivity. In all cases, the GCM scenarios predicted increased algal productivity for Castle Lake under conditions of doubled atmospheric CO2. The primary cause of enhanced productivity was the increased length of the growing season resulting form earlier spring ice-out. (Author's abstract) W91-10819

ULTRASTRUCTURAL AND BIOCHEMICAL EFFECTS OF CADMIUM ON THE AQUATIC FERN MARSILEA MINUTA LINN.

Industrial Toxicology Research Centre, Lucknow (India). Ecotoxicology Section. For primary bibliographic entry see Field 5C. W91-10829

INITIAL EVALUATION OF DEVELOPMENTAL MALFORMATION AS AN END POINT IN MIXTURE TOXICITY HAZARD ASSESSMENT FOR AQUATIC VERTEBRATES

Tennessee Univ., Knoxville. Coll. of Veterinary Medicine.

For primary bibliographic entry see Field 5C. W91-10832

MACROINVERTEBRATE RESPONSES ALONG A COMPLEX REGULATED STREAM ENVIRONMENTAL GRADIENT. Colorado State Univ., Fort Collins. Dept. of Biol-

ogy. For primary bibliographic entry see Field 4A. W91-10848

OCCURRENCE OF A SOUTH AMERICAN AR-MORED CATFISH IN THE HILLSBOROUGH

RIVER, FLORIDA.
Florida Dept. of Natural Resources, Clermont.
M. E. Ludlow, and S. J. Walsh.
Florida Scientist FLSCAQ, Vol. 54, No. 1, p 4850, Winter 1991. 1 tab, 6 ref.

Descriptors: \*Catfish, \*Fish establishment, \*Fish populations, \*Florida, Canals, Hillsborough River.

Although loricariid catfishes have been reported Although Ioricariia cattisnes have even reported from the Tampa Bay area for several decades, until recently they had not been demonstrated from the Hillsborough River drainage, Hillsborough County, Florida. The construction of a new canal. system may have allowed ingress of the South American catfish Pterygoplichthys cf. multiradia-tus into the Hillsborough proper. Accurate identifi-cation of this exotic species is difficult because of the unresolved toxonomy of hypostomine loricar-iids, and since the area in South America where the Hillsborough River population originally came from is unknown. Casual observations indicated that Pterygophichthys is presently abundant in Hillsborough State Park. Their worm-like feces are conspicuous in shallow areas of the river bottom. conspicuous in snattow areas of the river obttom. Eutrophication of the river which has resulted in heavy algal growth on benthic substrates has prob-ably been beneficial to this species. The potential impact of this exotic catfish on the community ecology of the river is unknown. Therefore, future research into the biological and ecological impacts of this algae-feeding armored catfish is recommended. (Author's abstract)
W91-10855

LONGITUDINAL DEVELOPMENT OF MA-CROINVERTEBRATE COMMUNITIES BELOW OLIGOTROPHIC LAKE OUTLETS. laho State Univ., Pocatello. Dept. of Biological

Great Basin Naturalist GRBNAR, Vol. 50, No. 4, p 303-311, December 1990. 6 fig, 2 tab, 8 ref.

Descriptors: \*Benthic fauna, \*Lake ecology, \*Lim-nology, \*Macroinvertebrates, \*Oligotrophic lakes, Aquatic habitats, Outlets, Particulate matter, Population dynamics, Seston, Species composition, Species diversity.

Benthic macroinvertebrates were collected at several sites downstream of three oligotrophic lake outfalls in July 1986. Total numbers, biomass, and species richness increased rapidly immediately downstream from the outlets, and then either stabilized or continued to increase downstream in parallel with benthic organic matter standing crops. Filter feeder densities showed an initial buildup and then decline downstream from the outlets. Variability in longitudinal patterns of other func-Variability in longitudinal patterns of other func-tional feeding groups among lake outlets was relat-ed to differences in food quantity and quality, and microhabitat. An additional set of samples was collected at Pettit Lake outlet in August 1986. Species richness and total density peaked sooner under baseflow conditions in June. Distributions of all functional feeding groups, except filter feeders, also differed between the two periods, reflecting differences in the obvisical environment. Reduced differences in the physical environment. Reduced differences in the physical environment. Reduced lentic inputs of particulate organic matter seston and improved habitat suitability downstream may be responsible for the progressive development of macroinvertebrate communities in oligotrophic lake outlets. These data imply the importance of the habitat templet in the structuring of benthic communities. (Author's abstract) W91-10856

ZOOPLANKTON EFFECTS ON PHYTO-PLANKTON IN LAKES OF CONTRASTING TROPHIC STATUS.

California Univ., Davis. Div. of Environmental J. J. Elser, and C. R. Goldman.

Limnology and Oceanography LIOCAH, Vol. 36, No. 1, p 64-90, January 1991. 12 fig, 6 tab, 49 ref.

Descriptors: \*California, \*Lake ecology, \*Limnology, \*Phytoplankton, \*Primary productivity, \*Trophic level, \*Zooplankton, Algae, Chlorophyll, Eutrophic lakes, Food chains, Grazing, Oligotrophic lakes, Phosphorus, Waterfleas.

Studies were carried out in three lakes of strongly contrasting trophic state to evaluate how the effects of zooplankton on phytoplankton vary as a function of lake productivity. Chlorophyll and total P concentrations differed by 2-3 orders of magnitude among ultra-oligotrophic Lake Tahoe, meso-oligotrophic Castle Lake, and strongly eutrophic Clear Lake. Three experimental designs involving short-term (4.0) manipulations of nutrients volving short-term (4 d) manipulations of nutrients, ambient zooplankton, and the common crustacean amoient zoopianston, and the common crustacean grazer Daphnia were performed in each lake. Algal responses were assessed at both the aggregate, community and species levels. Experiments in Lake Tahoe revealed a high degree of nutrient sensitivity but negligible grazing impacts by the very low densities of ambient zooplankton. Daphnia grazing had substantial impacts on Tahoe phytoplankton, indicating high supervibility to general parts of the properties of th toplankton, indicating high susceptibility to graz-ing in this assemblage of relatively small-sized algal species. Castle Lake exhibited strong direct and species. Castle Lake exhibited strong uncer and indirect impacts of both ambient zooplankton and Daphnia on the nutrient-limited algal assemblage. Dapnia on the nutrient-imited aigal assemblage. The cyanobacteria-dominated algal community of Clear Lake was resistant to grazing impacts, re-sponding relatively weakly only to the higher den-sities of Daphnia. Good correspondence between

estimates of algal biomass made from chlorophyll measurements and microscopic examination were obtained, and, in Castle Lake, concordance between estimated community productivity turnover tween estimated community productivity turnover times made from species-specific growth determinations and community productivity measurements was observed. The contrasting responses to experimental zooplankton manipulations in the three lakes support the view that the coupling between zooplankton and phytoplankton is strongest in the lakes of intermediate productivity and imply that food-web alterations at the top of the food web are most likely to propagate to the level of the phytoplankton (and therefore lake water quality) in lakes of moderate trophic status. (Author's abstract) W91-10859

SECCHI DISK AND PHOTOMETER ESTI-MATES OF LIGHT REGIMES IN ALASKAN LAKES: EFFECTS OF YELLOW COLOR AND TURBIDITY.

Alaska Dept. of Fish and Game, Soldotna. Fisher-ies Rehabilitation, Enhancement and Development

J. P. Koenings, and J. A. Edmundson.

Limnology and Oceanography LIOCAH, Vol. 36, No. 1, p 91-105, January 1991. 6 fig, 7 tab, 54 ref.

Descriptors: \*Alaska, \*Color, \*Lakes, \*Limnology, \*Photometry, \*Secchi disks, \*Transparency, \*Turbidity, Chlorophyll, Light penetration, Particulate matter, Trophic level.

Variations in underwater light regimes among 58 Alaskan lakes were indexed by Secchi disk (SD) transparency and by vertical attenuation coeffi-cients (K-d) and euphotic zone depths (EZD) decients (K-d) and euphotic zone depths (EZD) derived from using a submarine photometer (SP) sensitive to photosynthetically active radiation (PAR). Lake-specific ratios between turbidity (light scattering) and color (light absorption) explained 52% of the variation (P<0.0001) in K-d x SD values, which ranged as a continuum between 0.52 and 3.8. A clear-water median value of 1.86 (range, 1.13-3.26) is elevated by color to a median of 2.70 (range, 1.81-3.83), whereas turbidity reduces the median value of 0.93 (range, 0.52-2.56). EZD:SD, PAR at the SD depth, and PAR reflection (backscatter) also changed with the turbidity to-color ratio. The nearly 10-fold ranges between K-d x SD (0.59-4.09) and EZD:SD (0.89-8.67) values taken from 35 studies on lakes, estuaries, values taken from 35 studies on lakes, estuaries, and oceans could be explained by color and turbidand oceans could be explained by color and turbidity differences. Background attenuation from small amounts of color (< 10 Pt units) and turbidity (<5 NTU) uncoupled SD and SP measurements from changes in chlorophyll a, limiting their use as an index of trophic state. Changes in K-d x SD can serve, however, as a useful index of system loading by turbid particulate material or organic color. (Author's abstract)
W91-10860

ROLE OF SEASONAL TURNOVER IN LAKE ALKALINITY DYNAMICS.

Marine Biological Lab., Woods Hole, MA. Ecosystems Center. G. W. Kling, A. E. Giblin, B. Fry, and B. J.

Limnology and Oceanography LIOCAH, Vol. 36, No. 1, p 106-122, January 1991. 6 fig, 5 tab, 40 ref.

Descriptors: \*Alkalinity, \*Lake sediments, \*Lakes, \*Limnology, \*Massachusetts, \*Turnover time, Cores, Hydrogen sulfide, Nitrification, Oxygenation, Seasonal variation, Stratification, Sulfates, Sulfides, Water chemistry.

Elemental cycles and alkalinity (Alk) production and consumption were studied in sediments from two ponds (Mares and Gull) in coastal Massachusetts. Intact cores were incubated in the laboratory and manipulated to simulate water-column anoxia and manipulated to simulate water-commit anotate stratification and oxygenation during turnover. Reactions with S dominated Alk budgets in Mares Pond, whereas in Gull Pond reactions with N contributed most to Alk change. In Mares Pond, control cores held anoxically produced Alk at an average rate of 2.66 +/-0.59 (SE, N=3) meq/sq m/d, mostly due to sulfate reduction. This rate was

# Lakes-Group 2H

similar to calculations from hypolimnetic monitorsimilar to calculations from hypolimnetic monitoring in the pond during summer stratification. In cores from Mares pond where the water column was aerated to simulate turnover, the reoxidation of S (1.3 meq sulfate/sq m/d) contributed most to consumption of Alk (3.5 meq/sq m/d); half of all Alk lost during the 40-d experiment was consumed in the first 4 d of turnover. In aerated cores from Gull Pond, Alk consumption (4.2 meq/sq m/d) was driven mostly by white first to the consumption (4.2 meq/sq m/d). was driven mostly by nitrification (2.8 meq/sq m/d). High rates of Alk consumption observed in oxidized cores illustrate the potential for rapid Alk loss during seasonal turnover. Pore water profiles of sulfate and Alk suggest that sulfide oxidation was strongest in the top 1 cm of sediment and reached to a depth of 3-4 cm. Oxidation occurred rapidly in response to turnover, and although H2S may have been oxidized initially, the oxidation of solid-phase species dominated after 1 or 2 d. An isotopic mass balance of S in two turnover cores showed that from 30-70% of the oxidized S originated as inorganic rather than organic S. (Author abstract) W91-10861

EFFECTS OF PH AND ALUMINUM ON THE GROWTH OF THE ACIDOPHILIC DIATOM ASTERIONELLA RALFSII VAR. AMERICANA. Michigan Univ., Ann Arbor. Dept. of Biology.

R. W. Gensemer. Limnology and Oceanography LIOCAH, Vol. 36, No. 1, p 123-131, January 1991. 3 fig, 3 tab, 30 ref.

Descriptors: \*Acid lakes, \*Acid rain effects, \*Aluminum, \*Diatoms, \*Phytoplankton, \*Toxicity, \*Water pollution effects, Algal growth, Copper, Hydrogen ion concentration, Iron, Toxicology.

The effects of pH and Al on the acidophilic diatom The effects of pH and Al on the acidophilic diatom Asterionella ralfsii var. americana were examined in axenic batch cultures. Experiments were performed under conditions of both high (pH 5) and low (pH 6) Al solubility over a range of concentrations from 0 to 30 micromoles/L total Al. Growth rates were analyzed with respect to analytically determined Al concentrations and to predicted changes in dissolved metal ion speciation in response to Al additions. Growth rates of A ralfsii e to Al additions. Growth rates of A. ralfsii were significantly reduced above 15 micromoles/L were significantly reduced above 15 merolinores Let total Al at both pH 5 and 6. Al additions increased estimated free ion activities of Al(3+), Fe(3+), and Cu(2+) through indirect chelator interactions at pH 5 and 6; therefore, all three were significantly correlated with growth rate reductions. Indely correlated with growth rate reductions. Inde-pendent manipulations of total Fe and Cu, howev-er, suggested that Al was not directly increasing either Fe or Cu free ion activities to toxic levels. Relationships of growth rates to both inorganic monomeric Al and to estimates of pAl were strongly pH-dependent with toxicity being greater per unit of dissolved Al concentrations at pH 6 than at pH 5. These results are consistent qualita-tively with predictions that H(+) ions can amelio-rate dissolved metal toxicity by competitively extively with predictions that H(+) ions can ameliorate dissolved metal toxicity by competitively excluding Al(3+) ions from binding to cell surface ligands. The impact of Al on natural phytoplanton populations therefore is likely to depend on a combination of pH-dependent Al solubility, the protonation of cell-surface ligands, and chelator-mediated metal speciation. (Author's abstract) W91-10862

ESTIMATION OF PHOSPHORUS EXCHANGE BETWEEN LITTORAL AND PELAGIC ZONES DURING NIGHTTIME CONVECTIVE CIRCU-LATION.

LATION.
Army Engineer Waterways Experiment Station, Spring Valley, WI. Eau Galle Lab.
W. F. James, and J. W. Barko.
Limnology and Oceanography LIOCAH, Vol. 36, No. 1, p, January 1991. 7 fig, 2 tab, 23 ref.

Descriptors: \*Lakes, \*Limnology, \*Littoral zone, \*Nutrient transport, \*Pelagic zone, \*Phosphorus, \*Water circulation, \*Wisconsin, Convection, Diurnal variation, Eau Galle Reservoir, Reservoirs,

A fluorescent dye was used in Eau Galle Reservoir, Wisconsin, to examine nighttime convective circulation patterns and exchanges of P between

the littoral and pelagic zones during 25-26 July and 12-13 September 1988. Cooler littoral bottom water moved into the pelagic zone at night as an interflow at 2.5 m in July and at 4.0 m in September. Warmer pelagic water moved into the littoral zone as a surface flow during both periods. The littoral zone exhibited high total P concentrations above the sediment in July, but much lower concentrations in September. Estimated net areal total P flux to the pelagics zone was 18. mg/sq m/d in P flux to the pelagioc zone was 1.8 mg/sq m/d in July but only 0.2 mg/sq m/d in September. Net areal total P flux in July accounted for about 22% of the summer average, lakewide internal total P load to the reservoir. The results suggest that load to the reservoir. The results suggest that circulation patterns induced by nighttime convective cooling are of potentially great importance to the P economy of this reservoir. Although P transport to the pelagic zone occurs primarily at intermediate depths near the base of the epilimnion, this source is available to migrating algal species, which are abundant in the reservoir. (Author's

SHIFTS IN FISH VERTICAL DISTRIBUTION IN RESPONSE TO AN INTERNAL SEICHE IN A STRATIFIED LAKE,

Canadian BioSonics Ltd., Chilliwack (British Co-

D. A. Levy, R. L. Johnson, and J. M. Hume Limnology and Oceanography LIOCAH, Vol. 36, No. 1, p 187-192, January 1991. 5 fig, 14 ref.

Descriptors: \*British Columbia, \*Fish populations, \*Lakes, \*Limnology, \*Salmon, \*Seiches, \*Thermal stratification, \*Vertical distribution, Diurnal mal stratification, \*Vertical distribution, Diurnal variation, Population dynamics, Quesnel Lake,

For ectothermic organisms in thermally stratified bodies of water, temperature provides a strong and unambiguous environmental signal. Juvenile sock-eye salmon in Quesnel Lake were nocturnally thermoselective and distributed in a narrow vertical band within the thermocline. Differences in vertical position across and between lake transects occurred when an internal seiche was active, as evi curred when an internal sectice was active, as evidenced by a short-term alteration in the thermal structure of the lake. Although juvenile sockeye altered their nocturnal vertical positions by several meters in response to the internal seiche, this displacement probably had only minor or insignificant effects on their growth and survival in the lake. The wave-induced nocturnal displacement was a considerable of the control of the contro small compared to the 50-80 m vertical ampliturde of diel vertical migration by juvenile sockeye within the system. The findings emphasize the importance of temperature controlling the noctrunal distribution of juvenile sockeye since selection behavior has important metabolic implications for the fish. (Author's abstract)

VISUAL INTERPRETATION OF A LANDSAT MOSAIC OF THE OKAVANGO DELTA AND SURROUNDING AREA. School of Agriculture, University of Bophuthats-

wana, South Africa. J. P. Watson.

Remote Sensing of the Environment RSEEA7, Vol. 35, No. 1, p 1-9, January 1991. 5 fig, 7 ref.

Descriptors: \*Botswana, \*Geomorphology, \*Landsat images, \*Okavango Delta, \*Remote sensing, \*Terrain analysis, \*Wetlands, Climatology, Deltas, Land use, Satellite technology, Surface

A mosaic of the Okavango delta and surrounding areas in Botswana was prepared from 4 color composite Landsat images. The Okavango River enters the swamp zone near the Botswana border. The first 130 km of the swamp is confined to a narrow trough known as the panhandle and then the river spreads out into a number of distributors. ies to form the delta. The climate of the area is semiarid; about 90% of the rainfall comes in the summer months from November to March. The winter months from June to September are mild and dry. Potential evaporation over the delta is high. The delta has an inflow of about 11 billion cubic meters a year and an average rainfall of 500 cubic meters a year and an average rannal or norm, or 5 billion cubic meters, a year. Flow in the Okavango delta formerly extended over a greater area than at present. The retreat of the water may be the result of several causes, including a reduction in rainfall in Angola or the delta. The Okavango delta and surrounding arga lies at an elevation in rainian in Angola or the detail. The Oka-vango delta and surrounding area lies at an eleva-tion of 850-1000 m. It comprises two major geo-morphological features: the Kalahari sand plain and the Okavango-Linyati depression. The study area is divided into several terrain types: swamp, area is divided into several terrain types; swamp, alluvium, lacustrine deposits, Kalahari sand plain, sand dunes, and bedrock. The three main types of land use are livestock grazing, wildlife, and arable. Livestock grazing and wildlife areas occupy 99% of the region and carry a cover of natural or seminatural vegetation related to the main terrain units. Thus the perennial swamp is characterized by the contribute sets of the seminatural series. by aquatic vegetation, the seasonal swamp is mostly grassland, and the Kalahari sand plains carries woodland. The small proportion of arable land is found mainly along drainage lines and in the seasonal swamp. (Sand-PTT) W91-10879

DELAY IN LAKE RECOVERY CAUSED BY IN-TERNAL LOADING.

Environment Institute, JRC Ispra, 21020 Ispra,

Environment Institute, JRC 15p/16, 115p/16, Varese, Italy.
G. Rossi, and G. Premazzi.
Water Research WATRAG, Vol. 25, No. 5, p 567575, May 1991. 5 fig, 2 tab, 13 ref.

Descriptors: \*Eutrophic lakes, \*Eutrophication, \*Lake restoration, \*Lake sediments, \*Limnology, \*Phosphora, \*Sediment contamination, \*Vater pollution sources, Italy, Lake Varese, Model studies, Nutrient transport, Sediment chemistry, Sediment-water interfaces.

A simplified model of the lake-sediment system is A simplified model of the lake-sediment system is proposed, which aims to predict the long-term evolution and the recovery time of eutrophied lakes. The model represents the state of lake and sediment each by means of a single variable. Having recourse to a well-defined set of assumptions for sediment processes, and adopting time dependent coefficients, the model balance equations can be solved analytically, and the evolution of the state variables towards steady-state condi-tions, can be discussed in terms of characteristic times of the considered system. Particular attention times of the considered system. Particular attention is devoted to the consequences of P saturation of the solid phase in surface sediment layers, i.e., to a situation which is frequently present in eutrophied lakes. The model is applied to the case of the highly eutrophied Lake Varsee (Northern Italy), in which internal P loadings from sediments appear to be substantial. Taking into account the coupling between lake and sediments, the time needed to attain the steady-state P concentration compatible with the present P loadings is evaluated as about 5 times the water renewal time of the lake. It is also shown to what extent the assumptions on sediment dynamics affect the model predictions. (Author's abstract)

MICROCYSTIS CHANGES ITS BUOYANCY IN RESPONSE TO THE AVERAGE IRRADIANCE IN THE SURFACE MIXED LAYER,

Amsterdam Univ. (Netherlands). Lab. voor Microbiologie.

B. W. Ibelings, L. R. Mur, R. Kinsman, and A. E.

Walsby.
Archiv fuer Hydrobiologie AHYBA4, Vol. 120, No. 4, p 385-401, February 1991. 7 fig, 2 tab, 42 ref.

Descriptors: \*Algae, \*Buoyancy, \*Cyanophyta, \*Lakes, \*Light effects, \*Limnology, \*Radiation, Algal blooms, Aquatic life, Colonization, Photosynthesis, Scum, Vertical distribution, Water

A number of gas-vacuole planktonic cyanobacteria have been shown to become more buoyant when exposed to light of low irradiance and to lose buoyancy and sink at high irradiance. By respond-ing in this way, colonial bloom-forming cyanobac-

# **Group 2H—Lakes**

teria like Microcystic aeruginosa may undergo marked diurnal changes in vertical distribution in lakes. A series of experiments and observations were performed on a Microcystis population in Vinkeveen Lake, in the Netherlands. Samples were Vinkeveen Lake, in the Netherlands. Samples were taken for the analysis of carbohydrate, protein, chlorophyll-a, cell turgor pressure, relative gas vesicle volume, buoyant density, buoyancy state, and colony concentration. Measurements of photosynthetically active photo irradiance were made at wavelengths between 400 and 700 nm. The microcystis colonies circulated within the surface mixed layer whose depth (usually 2 to 4 m) usually ex-ceeded the euphotic depth (usually less than 1.5 m) in this wind-exposed lake. Colonies held in bottles in this wind-exposed lake. Colonies held in bottles at the lake surface responded to the high irradiance by losing their buoyancy, while those at greater depths remained buoyant. For colonies circulating within the surface layer the degree of buoyancy loss that occurred during the day depended on the mean irradiance to which they were exposed, which could be determined from the average surface. which could be determined from the average sur-face irradiance, the mixed depth and the vertical extinction coefficient. Buoyancy loss was also cor-related, but less strongly, with the proportion of the daytime spent by colonies within the euphotic zone. Surface scums were usually prevented from forming by wind mixing. (Agostine-PTT) W91-10895

ECOPHYSIOLOGICAL SIGNIFICANCE OF THE DIEL BIOCHEMICAL CHANGES OF PARTICULATES COUPLED WITH METABOL-IC AND ENVIRONMENTAL PARAMETERS IN TWO TROPHICALLY DIFFERENT LAKES, Clermont-Ferrand-2 Univ., Aubiere (France). Lab.

de Zoologie et Protistologie.

L. Aleya. Archiv fuer Hydrobiologie AHYBA4, Vol. 120, No. 4, p 403-432, February 1991. 13 fig, 4 tab, 79

Descriptors: \*Algae, \*Diurnal variation, \*Environ-mental effects, \*Lakes, \*Limnology, \*Particulate matter, \*Physiological ecology, Algal growth, Biochemistry, Lacustrine environment, Metabo-lism, Nitrogen, Oxidation, Photoactivation, Troph-

The diel variations of biochemical particulate parameters (proteins, carbohydrates, lipids, adenine nucleotides, chlorophyll-a) together with metabolic indicators (primary producers, adenylate energy charge) as well as population variables (algal species composition) and nutrient availability in lacustrine environments were investigated. This was an effort to study the combined effects of these parameters on the diel biochemical changes of particulates in two trophically different lakes: Aydat and Pavin lakes in Massif Central, France. Aydat Lake is a dimictic eutrophic lake, and Pavin is a meromictic (mixmomnimoliminon at 55 m) and dimictic mictic (mixomonimolimnion at 55 m) and dimictic (with partial overturns) oligo-mesotrophic lake.
Nitrogen concentration in the water appears to play a major role in controlling algal metabolism.
Lack of nitrogen induces accumulation of reserve products during the day and their use in the night when oxidative phosphorylation prevails and pho-tophosphorylation is absent. (Agostine-PTT) W91-10896

ROLE OF PHOSPHORUS CYCLING IN ALGAL METABOLISM AND ALGAL SUCCES-SION IN LAKE DONGHU, CHINA. Academia Sinica, Luojiashan (China). Inst. of Hy-

drobiology. For primary bibliographic entry see Field 5C. W91-10897

ALTERNATING DYNAMICS OF ROTIFERS AND DAPHNIA MAGNA IN A SHALLOW Max-Planck-Inst. fuer Limnologie zu Ploen (Ger-

Max-Planck-inst. tuer Limnologie zu Pioen (Germany, F.R.). W. Lampert, and K. O. Rothhaupt. Archiv fuer Hydrobiologie AHYBA4, Vol. 120, No. 4, p 447-456, February 1991. 6 fig, 1 tab, 18

Descriptors: \*Aquatic animals, \*Lakes, \*Limnology, \*Population density, \*Rotifers, \*Waterfleas,

Biomass, Competition, Dynamics, Organic carbon, Particulate matter, Plankton, Seasonal variation.

An inverse relationship between the abundance of rotifers and large daphnids has been documented. Grosser Binnensee, a shallow lake in Northern Germany, was inhabited by an interesting population of Daphnia magna in 1987. During a study of the zooplankton as part of a detailed investigation of the lake, a field example of the inverse relationship of Daphnia and rotifers was discovered. The seconal duranties of these two components of the seasonal dynamics of these two components of the zooplankton community were analyzed. Several cycles occurred during one year in the same lake, so that repetitive analyses of the Daphnia-rotiferso that repetitive analyses of the Daphnia-rotifer-food interactions during different seasons were possible. Rotifers and Daphnia magna showed strongly alternating population fluctuations. Daphnia appeared relatively late in the season and produced four pronounced biomass peaks between July and November. Three of the four peaks were associated with clear-water phases and reduced concentrations of sestonic carbon. The highest rotifer densities occurred before the daphnids appeared, and later in the season, the rotifer populations crashed when daphnids became abundant. Rotifer density was negatively correlated with Daphnia biomass but positively with particulate organic carbon levels. Most of the variation in rotifer abundance could be explained by fluctuations of POC levels, suggesting the existence of exploitative competition as a mechanism causing exploitative competition as a mechanism causing the inverse relationship between rotifers and Daphnids. However, a closer inspection of the time course of events indicates that mechanical interfer-ence may also be a factor and may have increased in importance as the season progressed and as the average size of daphnid individuals increased. (Agostine-PTT)

DIEL OXYGEN CYCLE IN THREE SUBAL-PINE SWISS STREAMS.

Zurich Univ., Kilchberg (Swizerland). Hydrobio-logical-Limnological Station.

D. M. Livingstone.

No. 4, p 457-479, February 1991. 6 fig, 1 tab, 38 ref. Swiss National Science Foundation Grant

Descriptors: \*Alpine regions, \*Dissolved oxygen, \*Diurnal variation, \*Oxygen, \*Streams, \*Switzer-land, Aeration, Consumptive use, Model studies, Productivity, Respiration, Snowmelt, Water tem-

Diel variations in the oxygen concentrations of three subalpine Swiss streams are explained in terms of reaeration, production and consumption, terms of reaeration, production and consumption, based on a model employing polynomial approxi-mations over parts of the diel curve. This approach allows useful information on the oxygen regime to be obtained without the necessity of modelling all parameters over the full diel cycle. Diel curves seen in the light of the model yield much information about the relative importance of biological and physical processes occurring in the streams. During the night the oxygen deficit tends toward, and often attains, an equilibrium deficit, which is directly related to the relative importance of community respiration and reaeration. The effect of meltwater on the oxygen regime is discussed and shown to be significant, suggesting that individual meteorological events can influence the oxygen regime of a stream so strongly that any seasonal variation will be hidden. A modification of Odum's method of calculating the daily production/consumption ratios in streams to take into account the influence of stream temperature on reaeration and tion about the relative importance of biological and influence of stream temperature on reaeration and respiration coefficients is given which should result in an improvement in the results obtained. (Author's abstract) W91-10899

GROUNDWATER FLOW AND THE METAL CONTENT OF PEAT.

Syracuse Univ., NY. Dept. of Geology. For primary bibliographic entry see Field 2F.

RIPARIAN ZONE AS A SOURCE OF PHOS-PHORUS FOR A GROUNDWATER-DOMINAT-ED LAKE.

Lund Univ. (Sweden). Dept. of Ecology.

Water Research WATRAG, Vol. 25, No. 4, p 409-418, April 1991. 7 fig, 25 ref.

Descriptors: \*Lakes, \*Nonpoint pollution sources, \*Nutrient transport, \*Path of pollutants, \*Phosphorus, \*Riparian land, \*Water chemistry, Conductance, Decomposing organic matter, Dissolved organic carbon, Ecosystems, Groundwater movement Streams

Recently it has been found that the riparian zone can contribute substantial amounts of dissolved nic carbon to a stream ecosystem. A study wa conducted in a groundwater-dominated lake in southern Sweden to determine if phosphorus can be liberated from the riparian zone and transported be hoerated from the ripariant zone and transported to the lake via shallow groundwater flow. Groundwater entering Lake Bysjon in southern Sweden is somewhat higher in specific conductance and up to 20 times higher in phosphate than the mean for the lake. This leads to elevated values of both specific conductance and phosphate in lake water within a conductance and phosphate in lake water within a 500 m long and several meter wide strip along the 500 m iong and several meter wide strip along the shore. In areas not influenced by groundwater inflow, specific conductance and phosphorus content near the shore are close to that of open lake water. High concentrations of phosphate (up to 9 mg/L PO4-P) in the inflowing groundwater originate from the riparian zone surrounding the lake. It is suggested that, over a long time, this ecotone has no suggested that, over a long time, this ecotone has accumulated phosphorus and other nutrients that were transported from the adjacent developed areas and arable land. This phosphorus is now entering the lake, probably as a result of increased decomposition of organic matter. (Agostine-PTT) W91-10931

DYNAMIC MODEL OF CAESIUM TRANS-PORT IN LAKES AND THEIR CATCHMENTS. Institute of Hydrology, Wallingford (England). For primary bibliographic entry see Field 5B. W91-10934

GREAT LAKES TOTAL PHOSPHORUS MODEL: POST AUDIT AND REGIONALIZED SENSITIVITY ANALYSIS.

Argonne National Lab., IL. Environmental Re-search Div.

search DIV.

B. M. Lesht, T. D. Fontaine, and D. M. Dolan.
Journal of Great Lakes Research JGLRDE, Vol.
17, No. 1, p 3-17, 1991. 5 fig, 6 tab, 22 ref. Interdepartmental purchase request 40WCNR901465 from
US Department of Commerce, National Oceanic
and Atmospheric Administration (Great Lakes Environmental Research Laboratory), through US Department of Energy contract W-31-109-Eng-38.

Descriptors: \*Great Lakes, \*Lakes, \*Limnology, \*Model studies, \*Phosphorus, \*Pollution load, \*Sensitivity analysis, \*Water pollution control, Data quality control, Environmental monitoring, Lake basins, Mass balance, Monte Carlo method, Simulation analysis.

More than a decade has passed since simple mass balance models were first used to establish target limits for phosphorus loading to the Great Lakes. Ongoing efforts to quantify both the loads to the lakes and the in-lake concentrations have resulted in a unique data set that can be used to evaluate the original application of the mass balance models. The multisegment mass balance model of Great Lakes total phosphorus developed in 1979 was used with annual phosphorus loading estimates to simulate phosphorus concentrations in 11 Great Lakes basins for the period 1974 to 1987. Compari-Lakes basins for the period 1974 to 1987. Comparison of the model results with field data collected since 1980 shows fairly good agreement, in spite of some overprediction of concentration in Lakes Superior and Ontario. A Monte Carlo technique known as regionalized sensitivity analysis was used both to identify those model parameters (including initial conditions) that were most important for producing an acceptable simulation and to examine new values for some model parameters. The model

Lakes-Group 2H

results were most sensitive to the parameters repreresults were most sensitive to the parameters repre-senting within-lake removal processes. Despite its simplicity, the Great Lakes total phosphorus model performed well and could be useful for establishing data quality objectives for phosphorus load esti-mates and surveillance programs. (Author's abstract) W91-10974

SIZE STRUCTURE OF PARTICULATE BIO-GENIC SILICA IN LAKE MICHIGAN. National Oceanic and Atmospheric Administra-tion, Ann Arbor, MI. Great Lakes Environmental

tion, Ann Arbor, M. Great Lakes Environmental Research Lab. D. J. Conley, and D. Scavia. Journal of Great Lakes Research JGLRDE, Vol. 17, No. 1, p 18-24, 1991. 5 fig, 22 ref.

Descriptors: \*Biochemistry, \*Diatoms, \*Lake Michigan, \*Lakes, \*Limnology, \*Silica, Cycling nutrients, Great Lakes, Microorganisms, Particle size, Particulate matter, Water chemistry.

Recent data suggest that chemical estimates of biogenic silica in the Laurentian Great Lakes include large fractions of non-living fragmented distons. Therefore, measurements of particulate biogenic silica (BSi) in different size classes (0.2-0.4 micrometers, 0.4-10 micrometers, 10-20 micrometers, and >20 micrometers) were made from April 10 micrometers. Lake Michigan 10 micrometers and page 10 micrometers and page 10 micrometers and page 10 micrometers. ters, and 20 metrointeers were made from Aprin through July 1987 in southeastern Lake Michigan to assess the importance of diatom fragments to chemical estimates of BSi. During the spring diatom bloom, the period of maximum BSi concentrations, the greatest percentage of BSi (86%) was found in the microplankton size fraction (>10 micrometers) associated with living diatoms. By contrast, following thermal stratification, when dissolved silica was depleted from epilimnetic waters, solved silica was depleted from epilimnetic waters, particles < 10 micrometers in size dominated and averaged 52% of total BSi. This fraction contained mostly fragmented diatom frustules. Our estimate of non-living diatoms is consistent with previous studies showing that, following the spring diatom bloom, 40% to 60% of total diatom abundance is non-living. Seasonal decreases in epilimnetic BSi, declining from 11.3 micromol/L in late April to an average of 1.96 micromol/L during the stratified period, were due primarily due to loss of the largest size fraction (>20 micrometers) which decreased from 76% of total BSi in April to 36% in July. BSi <10 micrometers varied by less than a creased from 76% of total 851 in April to 36% in July. BSi <a href="April to 36%" and July. BSi <a href="April to 36%" and factor of two throughout the study period, averaging 3.23 plus-or-minus 2.79 micromol/L. Particles 0.2-0.4 micrometers averaged 0.277 plus-or-minus 0.178 micromol/L. These particles are probably produced through frustule dissolution, settle slowly, and may lead to enhanced BSi recycling stees. As the of softender. rates. (Author's abstract) W91-10975

RECENT SEDIMENTATION IN LAKE MICHI-

GAN. Wisconsin Univ.-Milwaukee. Dept. of Civil Engineering. For primary W91-10976 ary bibliographic entry see Field 2J.

ACUTE PHOTOTOXICITY OF HARBOR AND TRIBUTARY SEDIMENTS FROM LOWER LAKE MICHIGAN.
Illinois Univ. at Urbana-Champaign. School of

For primary bibliographic entry see Field 5C. W91-10977

SUMMER CIRCULATION IN THE KINGSTON

SUMMER CIRCULATION IN THE AINOSION BASIN, LAKE ONTARIO.
McMaster Univ., Hamilton (Ontario). Dept. of Civil Engineering and Engineering Mechanics.
I. K. Tsanis, A. Masse, C. R. Murthy, and K.

Miners.

Journal of Great Lakes Research JGLRDE, Vol.
17, No. 1, p 57-73, 1991. 15 fig, 1 tab, 15 ref.

Descriptors: \*Kingston Basin, \*Lake Ontario, \*Lake basins, \*Limnology, \*Water circulation, \*Water currents, Great Lakes, Lake breezes, Remote sensing, River basins, Stratified flow, Wind-driven currents.

During the summers of 1986 and 1987 a network of During the summers of 1996 and 1987 a retwork of current meter moorings, meteorological buoys, and satellite drifters was deployed by National Water Research Institute (NWRI) to examine the circulation in the Kingston basin and St. Lawrence River outflow area. Power density spectra were computed along vector components and clockwise and countried observing the components and clockwise and countried observing the components. ed along vector components and clockwise and counterclockwise components. Coherence and phase were computed between surface and bottom currents at the same mooring, and between current and wind stress. The analysis reveals a varied response of currents to wind stress throughout the response of currents to wind stress inrougnout the basin and indicates the existence of complicated hydraulic and wind-induced circulation patterns. The principal axes and mean direction of the measured currents shows that the flow is strongly influenced by bottom topography. The numerous islands in the Kingston basin affect the circulation. The record mean flow along the north side of Ambert leand is much however the current the stress than the stress of the The record mean flow along the north side of Amherst Island is weak; however, the currents exhibit high variability in response to barotropic pressure gradients induced by wind-driven water level set-up, with the flow around Amherst Island being 180 degrees out of phase with the wind. During the summer months the flow in the Kingston basin is stratified, resulting in two-layer flow at the boundary between the basin and Lake Ontario. The mean currents in the epilimnion move landward toward the St. Lawrence River mouth while ward toward the St. Lawrence River mouth while the mean currents in the hypolimnion move lakeward toward Lake Ontario through three deep channels. (Author's abstract) W91-10978

POLYCHLORINATED BIPHENYLS IN DATED SEDIMENT CORES FROM GREEN BAY AND LAKE MICHIGAN.

Wisconsin Univ.-Milwaukee. Dept. of Civil Engi-For primary bibliographic entry see Field 5B. W91-10979

OPTICS OF LITTLE SODIS BAY.

Upstate Freshwater Inst., Inc., Syracuse, NY.
S. W. Effler, M. G. Perkins, and B. A. Wagner.
Journal of Great Lakes Research JGLRDE, Vol. 17, No. 1, p 109-119, 1991. 8 fig, 1 tab, 32 ref.

Descriptors: \*Lake Ontario, \*Light penetration, \*Limnology, \*Optical properties, \*Transparency, \*Water properties, Calcium carbonate, Great Lakes, Irradiation, New York, Opacity, Secchi

The optical properties of water have important implications with respect to heating, primary productivity, and esthetics. Optical properties of Little Sodus Bay (New York) were examined for the summer to fall interval of 1988 and contrasted to those at an adjoining Lake Ontario station. Light penetration, the angular distribution of irradiance, and the spectral quality of underwater irradiance were quantified by measurements with a Secchi were quantified by measurements with a Secchi disk, quantum sensors, and a spectroradiometer. A partitioning of light absorbing and light scattering components was developed. Light attenuation was much higher in the bay than in the lake because of the elevated levels of light absorption and scattering that prevailed in the bay, associated with the higher concentrations of phytoplankton, gelbstoff, and perhaps tripton. The enrichment with these materials also caused disparate spectral attenuation characteristics between the bay and the lake that characteristics between the bay and the lake that were manifested as strong differences in appearwere manifested as strong differences in appearance. Calcium carbonate particles were an important component of light scattering in both systems in the early part of the study. This material had a particularly striking effect on the angular distribution of irradiance in the lake. (Author's abstract)

PHOSPHORUS FROM INTERNAL SOURCES IN THE LAURENTIAN GREAT LAKES, AND THE CONCEPT OF THRESHOLD EXTERNAL

Freshwater Research, R.R. 1, Baysville, Ontario POB 1AO

For primary bibliographic entry see Field 5B. W91-10982

THREE-DIMENSIONAL NUMERICAL MOD-ELLING OF WIND-DRIVEN CIRCULATION IN A SHALLOW HOMOGENEOUS LAKE.

Bradford Univ. (England). Dept. of Civil Engineering and Structural Engineering.
R. A. Falconer, D. G. George, and P. Hall.
Journal of Hydrology JHYDA7, Vol. 124, No. 1/
2, p 59-79, April 1991. 10 fig, 38 ref.

Descriptors: \*Lakes, \*Limnology, \*Mathematical models, \*Model studies, \*Water circulation, \*Wind-driven currents, England, Finite difference methods, Numerical analysis, Shallow water.

In the management and operation of natural lakes and manmade reservoirs, hydraulic engineers are increasingly required to analyze and predict the mixing characteristics for wind-induced lake circumixing characteristics for wind-induced lake circu-lation using deterministic numerical models. The development, validation, and application of a three-dimensional deterministic numerical model of the wind-induced circulation in a shallow homoge-neous lake were examined. The governing equa-tions expressing the conservation of fluid mass and momentum were solved in the model using an implicit finite difference initial value method. Parimplicit finite difference initial value method. Parimplicit limits of interestic mittal value inclinds. The intitual rattention was paid to the representation of the bed friction, the wind shear stress, and turbulent diffusion. The model was compared with analytical solutions for three idealized flows before being calibrated and verified with field data from Esthwaite Water in Cumbria, England. The model was tested for stability and parameter sensitivity and then used to generate typical circulation pat-terns for a variety of steady-state conditions. Com-parisons with field measurements suggest that the model is better at predicting water movements in the open water than in the sheltered bays. (Author's abstract) W91-10992

REVIEW OF INTERBASIN WATER TRANSFERS WITH SPECIFIC ATTENTION TO FERS BIOTA.

North Dakota State Univ., Fargo. Dept. of Civil Engineering. For primary bibliographic entry see Field 6B.

GREAT LAKES LEVELS AND FLOWS UNDER NATURAL AND CURRENT CONDITIONS.

Inland Waters Directorate, Burlington (Ontario). Water Planning and Management Branch. C. Southam, and G. Larsen.

Its: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 181-190, 2 fig. 2 tab, 12 ref.

Descriptors: \*Environmental effects, \*Great Lakes, \*Model studies, \*Water level, \*Water re-sources development, Flow profiles, Lake Erie, Lake Huron, Lake Michigan, Lake Ontario, Lake Superior, Lake morphology.

The water levels of the Great Lakes have fluctuat-The water levels of the Great Lakes have fluctuationed for thousands of years in response to a number of natural factors. More recently, society's development in the watershed has influenced the water levels of the Great Lakes. The individual and combined impacts of lake level regulation, channel modification, ice control measures, and diversions were assessed. Models based on the Great Lakes supplies routing model were used to simulate 'natu-ral' and 'current' condition Great Lakes levels and flows by assuming these factors both removed and in place. The models were run for the 1900-1986 period using recorded Great Lakes net basin supplies. It was found that the noted societal influplies. It was found that the noted societal influences have raised the average levels of Lakes Superior and Erie about 0.3 foot and 0.1 foot respectively whereas, Lakes Michigan-Huron and Ontario average levels have been lowered about 1.1 feet and 0.2 foot, respectively. The results show that while individual regime changes can have a significant impact on levels, in combination they often compensate one another. (See also W91-11003) (Author's abstract)

#### Group 2H-Lakes

1987-89 DROP IN GREAT LAKES WATER LEVELS, CAUSES AND EFFECT.

LEVELS, CAUSES AND EFFECT.
Inland Waters Directorate, Burlington (Ontario).
Water Planning and Management Branch.
P. Yee, D. Cuthbert, and R. Moulton.
IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 191-201, 3 fig, 5 tab, 7 ref.

Descriptors: \*Great Lakes, \*Regulated flow, \*Water level, \*Water resources management, Evaporation, Lake Ontario, Lake Superior, Lake morphology, Low flow, Precipitation, Recreation,

After 20 yrs of above-average Great Lakes levels including the record high levels in 1985 and 1986, the Lakes experienced an unprecedented rapid drop in levels beginning in late 1986. This drop in Great Lakes levels surpassed that of the previous 20th century extreme event of 1930-31. Precipita-20th century extreme event of 1930-31. Precipitation was low from late fall of 1986 to June 1987, and again in the spring of 1988. Also, low runoff and high evaporation in the basin were experienced. While regulation of Lake Superior levels was not a factor in the decline of levels, regulation of Lake Ontario levels during this period had some impacts on that lake and downstream. Very high outflows from Lake Ontario made that the only Lake to escape setting record high levels. Over the last two years, new kinds of water level problems have surfaced throughout the watershed. Shoreline residents are unaccustomed to average or slightly residents are unaccustomed to average or slightly below average levels after 20 yrs of high levels. Recreational boats striking bottom in nearshore areas, unusable boat docking facilities and reduced water depths in the St. Lawrence River have been cause for concern. (See also W91-11003) (Author's abstract) W91-11023

MODELING LAKE ERIE AS A STOCHASTIC LINEAR RESERVOIR.

Cincinnati Univ., OH. Dept. of Civil and Environ-

mental Engineering.
For primary bibliographic entry see Field 7C.
W91-11029

EXECUTIVE SUMMARY-ASSESSING THE RESPONSE OF EMERALD LAKE, AN ALPINE WATERSHED IN SEQUOIA NATIONAL PARK, CALIFORNIA, TO ACIDIFICATION DURING SNOWMELT USING A SIMPLE HY-DROCHEMICAL MODEL.

Geological Survey, Doraville, GA. Water Resources Div. For primary bibliographic entry see Field 7C. W91-11112

NATURE OF SUSPENDED SOLIDS AND IRSIA-LISSI DATA: A CASE STUDY OF TAWA RESERVOIR (NARMADA BASIN).
Jawaharlal Nehru Univ., New Delhi (India). School of Environmental Sciences. For primary bibliographic entry see Field 5G. W91-11221

SUBICE LAYERING AND ORIGIN OF ACIDIC WATERS IN A SMALL BOREAL LAKE DURING THE SPRING RUNOFF.
Institut National de la Recherche Scientifique,

Sainte-Foy (Quebec).
For primary bibliographic entry see Field 5B.
W91-11229

EFFECT OF HYDROELECTRIC STATIONS ON WATER QUALITY AND DEVELOPMENT OF PHYTOPLANKTON IN THE LOWER POOLS OF RESERVOIRS.

mary bibliographic entry see Field 6G.

CONTAMINATION OF PONDS BY FENI-TROTHION DURING FOREST SPRAYING. Environmental Protection Service, Dartmouth

For primary bibliographic entry see Field 5B. W91-11298

TRANSPORT OF THE FUNGICIDE CHLOR-OTHALONIL FROM ITS OPERATIONAL USE ON A POND ECOSYSTEM. Inland Waters Directorate, Moncton (New Bruns-

wick). Water Quality Branch.
For primary bibliographic entry see Field 5B.
W91-11299

INFLUENCE OF PH ON PHOSPHATE RE-LEASE FROM SEDIMENTS.

Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands). P. C. M. Boers.

P. C. M. Boers. Water Research WATRAG, Vol. 25, No. 3, p 309-311, March 1991. 3 fig, 2 tab, 9 ref.

Descriptors: \*Carbon dioxide, \*Cycling nutrients, \*Hydrogen ion concentration, \*Limnology, \*Phosphates, \*Sediment chemistry, Sediment-water nterfaces.

In eutrophic lakes, a release of phosphates from the sediments can be an important source of nutrients from the phytoplankton community. Often, the release rate is higher in the summer when tempera-tures are higher, sediment conditions are anaerobic and pH values in the water column are high. and pH values in the water column are high. Hydrogen ion concentration is believed to be an important regulating factor for the release of phos-phate from freshwater sediments. Usually this is demonstrated in laboratory experiments using intact sediment cores and pH regulation of the overlaying water by means of NaOH additions. This technique and a pH regulation technique by means of CO2-stripping were compared. The first method resulted in a 10-fold increase in release rate at pH 9.5 compared to the rate at pH 8.3. The method resulted in a 10-fold increase in release rate at pH 9.5 compared to the rate at pH 8.3. The stripping technique yielded only a doubling of the release rate at pH 9.3. Measurements of pH profiles in the sediment in experiments performed at pH 8.3 and 9.0 proved that the enhanced phosphate release when using NaOH for pH regulation is mainly an artifact caused by an increased alkalinity in the water column and the upper sediment layers, resulting from the NaOH additions. In eutrophic lakes, however, the algae can strip so much CO2 that pH values as high as 10 are possible. The results with pH 9.0 and 9.3 indicate that phosphate release rates still increase significantly with high release rates still increase significantly with high pH, although attempts to measure the natural proc-ess by NaOH addition, probably do not reflect the true process of pH increase due to CO2 depletion. W91-11327

SIMPLIFIED PHOSPHORUS TROPHIC STATE MODEL FOR WARM-WATER TROPI-

Pan American Center for Sanitary Engineering and Environmental Sciences, Lima (Peru). For primary bibliographic entry see Field 5C. W91-11332

IN-SITU SEDIMENT OXYGEN DEMAND IN FIVE SOUTHWESTERN U.S. LAKES. Oklahoma State Univ., Stillwater. School of Civil

Engineering.

J. N. Veenstra, and S. L. Nolen.

Water Research WATRAG, Vol. 25, No. 3, p 351-354, March 1991. 2 tab, 20 ref.

Descriptors: \*Dissolved oxygen, \*In situ tests, \*Lakes, \*Sediment chemistry, \*Sediment oxygen demand, \*Sediment-water interfaces, \*Water quality monitoring, Analytical methods, Biological oxygen demand, Chemical oxygen demand, Measuring instruments, Oxygen demand.

The rate of oxygen removal from overlying water, either by biological means or chemical oxidation of substances in the bottom material of a water body may be termed sediment oxygen demand (SOD). Reliable and accurate SOD measurement techniques and data of this potential sink for dissolved oxygen are essential for many water quality model-ing studies. In-situ SOD was measured for five

southwestern lakes from 1985 to 1988. Age, mor-phology and trophic states varied among the lakes but all were thermally stratified and had anoxic hypolimnia during summer months. SOD measure-ments were obtained with a hemispherical, sealed chamber-type benthic respirometer fitted with a submersible recirculation pump and a sensor pack-age for recording dissolved oxygen, temperature, conductivity and pH. SOD measurements were obtained at between two and four sites on most lakes. Temperature corrected values ranged from 0.34 to 9.02 g O2/sq m/d. The coefficient of variation of the SOD monitoring technique used ranged from 19% to 36%. These data significantly expand the currently accessible SOD data base for Southwestern lakes. While limited data preclude extensive statistical analysis, it appears that there may be a rough correlation between mean chlorophyll a levels and SOD. (Doyle-PTT) W91-11333

MULTICOMPONENT KINETIC ANALYSIS OF IRON SPECIATION IN HUMIC LAKE TJEU-KEMEER: COMPARISON OF FULVIC ACID FROM THE DRAINAGE BASIN AND LAKE WATER SAMPLES.

CB Research International Corp., Sidney (British

Le. E. Sojo, and H. De Haan. Environmental Science and Technology ESTHAG, Vol. 25, No. 5, p 935-939, May 1991. 5 fig, 2 tab, 25 ref.

Descriptors: \*Chemical speciation, \*Eutrophic lakes, \*Fulvic acids, \*Humic substances, \*Iron, \*Limnology, \*Water chemistry, Acidification, Catchment areas, Kinetics.

The importance of humic substances in the circulation of nutrients in humic lakes has been more often inferred than actually verified. Although laboratory studies are necessary in order to under-stand the main features of nutrient (i.e., Fe) interacstand the main reatures of nutrient (i.e., re) interac-tions with humic substances, studies including actual samples are necessary. Evidence for iron-fulvic acid complexes in natural waters is difficult to obtain due to the complexity of iron speciation. The strong tendency of iron to form hydrous oxides presents a competitive reaction against the formation of iron-fulvic acid complexes. A series formation of incineuve acid complexes. A series of experiments were conducted to study iron speciation in Lake Tjeukemeer water samples and sediments, using multicomponent kinetic analysis. The technique is based on the ligand-exchange reactions of the control tions between naturally occurring ligands (i.e., fulvic acids, OH(-), etc.) and a strong iron complexing agent (i.e., 2,4.6-ti(2-yridyl)s-triazine (TPTZ)). Guggenheim's method of kinetic analysis was then used to provide estimates of rate con-stants and initial species concentrations. The kinet-ic data obtained from the experiments revealed that iron was distributed among iron-fulvates and polymeric hydrous oxide species. The results of the study provided support for the use of multi-component kinetic analysis to determine iron speciation in natural water samples. In addition, this technique can be used to monitor changes in iron speciation due to seasonal variations and changes in water quality. (Korn-PTT) W91-11339

PERIODIC DRAINAGE OF ICE-DAMMED LAKES AS A RESULT OF VARIATIONS IN GLACIER VELOCITY. Keele Univ. (England). Dept. of Geography. For primary bibliographic entry see Field 2C.

W91-11348

AVALON LAKES: AN ENVIRONMENTAL OP-

For primary bibliographic entry see Field 6G. W91-11362

DENDROGEOMORPHIC APPROACH TO MEASUREMENT OF SEDIMENTATION IN A FORESTED WETLAND, BLACK SWAMP, AR-KANSAS.

Lakes-Group 2H

C. R. Hupp, and E. E. Morris. Wetlands, Vol. 10, No. 1, p 107-124, 1990. 7 fig, 2 tab, 42 ref.

Descriptors: \*Black Swamp, \*Dendrochronology, \*Dendrogeomorphology, \*Geomorphology, \*Sedimentation, \*Wetlands, Arkansas, Baldcypress trees, Cache River, Data acquisition, Forest wetlands, Sedimentation rates, Swamps, Tupelo trees.

Dendrogeomorphic techniques were used to describe and interpret the spatial and temporal patterns of sedimentation in the Black Swamp, located along the Cache River in eastern Arkansas. At 30 sites along four transects, 148 trees were examined for depth of sediment accretion and cored for age sites atong from transects, I we trees were examined for depth of sediment accretion and cored for age determination. Tree ring and geomorphic analyses indicated that mean sedimentation rates were significantly related to site elevation, topographic position, and the distribution of tupelo gum and bald cypress. Maximum mean rates of sedimentation, as high as 0.60 cm/hr, generally occurred in sloughs, areas low in elevation, and where tupelo gum and bald cypress grow. Mean sedimentation rate appeared to have a negative exponential relation with increasing elevation. Tree age class data indicated a significant increase in sedimentation rate about 1945, from a mean at or below 0.01 cm/yr to a mean of 0.28 cm/yr for the past 19 years. Dendrogeomorphic techniques provide valid estimates of sedimentation rate and allow for the integration of decades of depositional processes in the rate calculations. decades of depositional processes in the rate calculation. (Author's abstract)
W91-11397

PHOSPHORUS LOSSES FROM THE EPILIM-

PHOSPHORUS LOSSES FROM THE EFILIM-NION IN RIMOV RESERVOIR. Ceskoslovenska Akademie Ved, Ceske Budejovice. Inst. of Landscape Ecology.

P. Porcalova. Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 75, No. 3, p 273-279, 1990. 2 fig, 3

Descriptors: \*Epilimnion, \*Eutrophication, \*Lim-nology, \*Phosphorus, \*Rimov Reservoir, \*Sedi-mentation rates, Biomass, Czechoslovakia, Eutro-phic lakes, Lake sediments, Phytoplankton, Sea-sonal variation, Sedimentation, Seston, Traps, Water chemistry.

Main components of the phosphorus budget of a reservoir are input, output, and sedimentation. Ex-ternal loading and phosphorus removal from the water column by sedimentation are crucial for reservoir phosphorus content. During eutrophica-tion processes, bottom sediments accumulate large quantities of phosphorus, which may be released into water under certain conditions. This release of mto water under certain continuous. In stelease of P from sediments and subsequent transport upward through the hypolimnion plays an important role in the development of the reservoir's trophic status. The amount of deposits accumulated during eutrophication is important, particularly in lake or reservoir restoration. Sediment traps were placed at three depths near the dam of the Rimov reservations of the Rimov reservations are the dam of the Rimov reservations. at three depths near the dam of the Rimov reservoir, Czechoslovakia, and at the bottom along the reservoir from April 1986 to April 1987. The highest amounts of phosphorus in trapped material was obtained during the fall turnover in the epilimnion, and near the bottom in both spring periods. During the growing period, variations in dry weight and total phosphorus in settling seston were related to changes of phytoplankton biomass in the trophogenic layer. The flux of settling phosphorus insettling seston was higher in the hypolimnion than in the epilimnion throughout the year. During summer stratification the variability of dry weight and phosphorus sedimentation followed changes in phytoplankton biomass in the epilimnion. Sedimentation measurements along the Rimov Reservoir showed that half of the phosphorus input was deposited within the first 3 km of the length of the reservoir. (Medina-PTT)

PROCESSING OF LEAVES OF TREES AND AQUATIC MACROPHYTES IN THE NETWORK OF THE RIVER RHONE.

Mohamed-1 Univ., Oujda (Morocco). Dept. de

H. Chergui, and E. Pattee. Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 75, No. 3, p 281-302, 1990. 8 fig, 2

Descriptors: \*Aquatic life, \*Decomposing organic matter, \*Detritus, \*Leaves, \*Macrophytes, \*Mi-crobial degradation, \*Rhone River, Alder trees, Aquatic fungi, Ecosystems, Literature review, Litter, Organic matter, Oxygen, Phragmites, Poplar trees, Willow trees.

The decomposition of vegetable particulate organin actecomposition of vegetable particular organ-ic matter is one of the major inputs of energy to aquatic ecosystems. A study was made on the processing of these inputs to record the availability of organic matter at different periods of the year. Dead leaves of three species of trees, alder, poplar Dead leaves of three species of trees, aider, poplar and willow, and two aquatic macrophytes. Potamogeton and Phragmites, were enclosed in coarse mesh (10 mm) and fine mesh (0.3 mm) plastic bags and exposed in two contrasted backwaters of the Rhone River (southeastern France). One was connected with a channel of the river at its downstream end, and the other on a completely closed oxbow lake. Regardless of the biotope, the break-down rate of leaves ranked in the following order: submerged and floating Potamogeton > aider and poplar > willow and emerging Phragmites. In coarse mesh bags, colonization of the leaves by invertebrates occurred in the same order. Shreders appeared first, with predators and collectors inverterates occurred in the same order. Shred-ders appeared first, with predators and collectors later. The time lag before colonization indicated that microbial conditioning of the leaves also pro-ceeded in the same order. The natural date of senescence and eventual immersion of the leaves sensether and eventual intersion of the leaves provided consumable allochthonous and autochth-onous organic matter to the river system through-out the year, from summer to the following spring. Comparison with earlier studies showed the exist-Comparison with earlier studies showed the existence of a transverse gradient in the fluvial network. Under the influence of fungal and invertebrate colonization, breakdown velocity was highest in the channel, less in the half-closed side arm, and lowest in the completely enclosed lake. These results suggest that this gradient was due initially to the indirect influence of water motion and oxygen availability on leaf colonization by Hyphomycetes. (Medina-PTT)
W91-11402

DOWNSTREAM CHANGES IN CADDISFLY COMPOSITION AND ABUNDANCE IN RELA-TION TO CHANGES IN WATER CONDUCTIV-ITY AND OXYGEN IN THE RIVER BUTRON BASIN.

Universidad del Pais Vasco, Bilbao (Spain). Lab. de Ecologia. For primary bibliographic entry see Field 5C. W91-11403

ASSESSMENT OF WATER POLLUTION USING DIATOM COMMUNITY STRUCTURE AND SPECIES DISTRIBUTION—A CASE STUDY IN A TROPICAL RIVER BASIN. Malaya Univ., Kuala Lumpur (Malaysia). Inst. for Advanced Studies. Auvanced Studies.
For primary bibliographic entry see Field 5C.
W91-11404

NATURAL PHOSPHATE SOURCE FOR LAKE WACCAMAW, NORTH CAROLINA, USA. North Carolina Univ. at Wilmington. Dept. of

L. B. Cahoon, J. R. Kucklick, and J. C. Stager. Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 75, No. 3, p 339-351, 1990. 3 fig, 4 tab, 32 ref.

Descriptors: \*Eutrophication, \*Lake Waccamaw, \*Limnology, \*Phosphates, Environmental chemistry, Eutrophic lakes, Lake management, Lake morphometry, Lake sediments, Limestone, North Carolina, Pollutant identification, Water chemistry, Water Chem Weathering.

Lake Waccamaw is one of the largest natural lakes in North Carolina and the largest of the Carolina Bay Lakes, a distinctive morphometric type with a shallow, elliptical basin. A limestone outcrop along

its north shore was found to contain 0.1% phosphate by weight. Weathering processes have probably driven steady inputs of phosphate from this source throughout the lake's history, accounting for its near-eutrophic state. The sediments of the lake are enriched with phosphate, particularly in the littoral zone near the outcrop. Chemical and biological processes apparently remove phosphate from solution rapidly, making detection of a soluble phosphate signal near the outcrop difficult. Management of nutrient inputs and water quality in Lake Waccamaw requires consideration of the Management of nutrient inputs and water quanty in Lake Waccamaw requires consideration of the effects of this in-lake source of phosphate. Other sources of phosphate, particularly in the lake drainage basin, may be less important than previously thought. (Author's abstract)

VARIATION IN THE ACIDITY OF GROUND AND SURFACE WATERS IN NORTHERN IRE-LAND.

Departm ent of Agriculture for Northern Ireland, Antrim. Freshwater Biological Investigation Unit. C. Jordan, and I. J. Enlander.

Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 75, No. 3, p 379-401, 1990. 9 fig, 5 tab, 51 ref.

Descriptors: "Acid rain, "Acidification, "Acidity, "Aluminum, "Groundwater chemistry, "Northern Ireland, "Water pollution effects, Acidic lakes, Drinking water, Environmental chemistry, Eutrophication, Geology, Hardness, Hydrogen ion concentration, Maps, Surface water, Trout, Water

It is known that Northern Ireland experiences deposition levels of hydrogen and sulfate ions which are high enough to acidify both surface and groundwaters in some upland areas where the soils have poor buffering capacities. Existing data on both surface and groundwater from around Northern Ireland were mapped using SYMAP techniques into one of 5 classes representing waters ranging from those which are permanently or occasionally acid (SYMAP class 1), to those with high enough buffering capacity that they never become acid under current levels of acid deposition (SYMAP class 2), and to those that are never likely to suffer from acidification (SYMAP class 3). The distribution of each class of water was likely to suffer from acidification (SYMAP class 3-5). The distribution of each class of water was explained on the basis of the regional geology and pedology of Northern Ireland and the ability of soils and rocks to neutralize incoming acidity. Aluminium levels in those areas identified as being vulnerable to acidification (the Mourne and Sperin mountains and the Glens of Antrium) were found to be between 72 and 241 microg/L total aluminum of which most was in its most toxic, labile form at the pH's of the waters concerned. However, a survey of the Silent Valley in the Mourne mountains, where the pH was known to Mourne mountains, where the pH was known to vary between 4.5 and 5.8, and where the labile aluminium concentration was 230 microg/L, showed that this public supply reservoir sustained showed that this public supply reservoir sustained a small population of apparently healthy brown trout in the age range of 1-4+. It was considered that sudden changes in pH or aluminium concentrations due to acid rain (pH = 3.8) in the vulnerable areas identified in this study posed the greatest threat to the survival of fish stocks in these areas. The largest lakes in the Province, Loughs Neagh and Erne, are not susceptible to acidification and have very low aluminium concentrations, all of which is non-labile. (Medina-PTT)

PROXIMATE COMPOSITION AND NUTRI-ENT ELEMENTS IN THE UNUSUAL ALGAL JELLIES OF LAKE OGUTA IN SOUTHERN

Port Harcourt Univ. (Nigeria). C. Nwadiaro, and P. Idabor. Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 75, No. 3, p 413-420, 1990. 2 tab,

Descriptors: \*Algal jellies, \*Lake Oguta, \*Nutrients, \*Plant populations, Algal mats, Algicides, Biofilms, Calcium, Chlorophyta, Cyanophyta, Dia-

# Group 2H-Lakes

genesis, Drinking water, Limnology, Magnesium, Nigeria, Potassium, Seasonal variation, Sodium, Species composition, Water quality.

Unusual planktonic algal communities, conveniently called algal jellies, are not common in tropical lakes, but have been reported in Japan and Northern Cameroon. There is a high similarity in the consistency and gross taxonomy of these Japanese and Nigerian algal formations. The proximate composition, nutrient and trace elements of algal jellies samples from Lake Oguta in Southern Nigeria were analyzed to provide guidelines for their utilization and management. Samples were obtained in the rainy (flood) and dry seasons. Species identification revealed mostly blue green algae (Microystis, Anabaena, Chroococcus) with some green algae (Spirogyra) and diatoms (Navicula) that were epiphytic on the mucous jellies of the blue-Unusual planktonic algal communities, convenientalgae (Spirogyra) and diatoms (Navicula) that were epiphytic on the mucous jellies of the bluegreen algae. Water content was high (98.2% mean, range 97.5-95.5%) Ash, protein and fat mean values were 41.7%, 16.9%, and 2.0%. Phosphorus and nitrogen levels were high, and the major cation order of dominance was Ca > K > Mg > Na, differing from that of the lake water. Macronutrient concentrations increased during the rainy season, concentratios of micronutrients decreased. seasonal changes in ionic concentrations were at-tributed to diagenesis of endogenic minerals and not to anthropogenic factors. The economic value of these jellies include its possible use as a fertilizer, compost and mulching material for agriculture, and, a protein source for fish and livestock feeds. The use of chemicals (algicides) to control algal growth was not practical in this lake due to the dependence of the local community on the lake as a direct source of drinking water. (Medina-PTT) W91-11408

GEOMORPHIC, GEOGRAPHIC, AND HYDROGRAPHIC BASIS FOR RESOLVING THE MONO LAKE CONTROVERSY.

Lamont-Doherty Geological Observatory, Palisades, NY. For primary bibliographic entry see Field 6G. W91-11442

TEMPERATURES LETHAL TO SALVINIA

MOLESTA MITCHELL.
Commonwealth Scientific and Industrial Research Organization, Indooroopilly (Australia). Div. of Entomology.

J. B. Whiteman, and P. M. Room. Aquatic Botany AQBODS, Vol. 40, No. 1, p 27-35, April 1991. 4 tab, 17 ref.

Descriptors: \*Aquatic weeds, \*Biocontrol, \*Ferns, \*Salvinia, \*Survival, \*Temperature effects, Cacti, Mortality, Nutrients, Submerged aquatic plants,

A laboratory study was undertaken to determine the effects of extreme temperatures on the survival of an aquatic weed, the Brazilian floating fern Salvinia molesta. Large phenets of S. molesta, each consisting of at least 12 ramets, were grown at different temperatures and durations of exposure at five different nutrient levels. At low temperatures, phenets survived all combinations of temperature, duration, and nutrient level, except for the -6 C setting, zero nutrients for 7 and 16 h, and high nutrients for 16 h. At high temperatures, there was nutrients for 16 h. At high temperatures, there was no survival at 6 and 16 h at the 48 C setting, and at 4 and 6 h at the 50 C setting. Examination of the temperatures actually experienced suggested that death occurred after plants had been exposed to water temperatures < -3 C for a few hours (when tice probably forms on the plant) or > 43 C for more than a few hours. This is within the ranges reported for some submerged aquatic plants and shade-inhabiting herbs. The upper temperature limit is low compared with the 50-55 C limit reported for herbs growing in the sun and 70-74 C limit is low compared with the 50-55 C limit reported for herbs growing in the sun and 70-74 C reported for cacti. Phenets appeared to survive low temperatures better when they were supplied with nutrients, but the effect was small. At high temperatures, greater survival of high-nutrient phenets at 40 C was contradicted by greater sur-vival of zero-nutrient phenets at 50 C. Experimental conditions were unrealistic in that plants re-ceived no light during exposures and did not experience gradual changes leading to and from exposure temperatures. (Doria-PTT) W91-11450

REGULATORY INFLUENCE OF WATER CUR-RENT ON ALGAL COLONIZATION IN AN UNSHADED STREAM AT SHILLONG (MEGH-ALAYA, INDIA). North-Eastern Hill Univ., Shillong (India). Dept.

For primary bibliographic entry see Field 2E. W91-11451

IMPACT OF CARBON DIOXIDE AND AMMO-

IMPACT OF CARBON DIVAIDE AND AMMO-NIUM ON THE GROWTH OF SUBMERGED SPHAGNUM CUSPIDATUM. Katholieke Univ. Nijmegen (Netherlands). Dept. of Aquatic Ecology and Biogeology. B. G. P. Paffen, and J. G. M. Roelofs. Aquatic Botany AQBODS, Vol. 40, No. 1, p 61-71, April 1991. 3 fig, 6 tab, 23 ref.

Descriptors: \*Ammonium, \*Carbon dioxide, \*Land use, \*Peat bogs, \*Peat harvesting, \*Plant growth, \*Plant physiology, \*Sphagnum, \*Sub-merged aquatic plants, \*Wetlands, Air pollution, Biomass, Mortality, Spectrophotometry, Statistical analysis, The Netherlands.

Plants of Sphagnum cuspidatum were collected from the peatland 'Groote Peel' (The Netherlands) and placed in glass containers to study the influand placed in glass containers to study the influence of carbon dioxide and ammonium on their growth. Results showed that at any CO2 level below 750 micromol/L, plants were in bad condition or dead. At 750 micromol/L the plants were fragile, but at 1,000 micromol/L most plants were very vital and floating, independent of the ammonium concentration of the medium. The percentage of living classification of the medium. of living plants after 12 weeks of cultivation was also the highest at 1,000 micromol CO2/L, independent of the amnonium level. The growth in length was also significantly higher at high CO2 levels than at the lowest CO2 level. The highest growth in length was found at the highest CO2 and ammonium concentration, but the differences between the various ammonium concentrations were not significant (Wilcoxon test). After a cultiwere not significant (Wilcoxon test). After a culti-vation period of 12 weeks the biomass decreased from initial biomass levels only at a CO2 level of 250 micromol/L (-19). The increase in biomass was greatest at a CO2 concentration of 1,000 mi-cromol/L (+18%). At high CO2 levels, biomass increased at all levels of mimonium. Element concentrations were generally higher after the culture period. It is concluded that the CO2 concentration of the water layer is of vital importance for the growth of submerged S. cuspidatum, at least 750 micromol CO2/L being necessary for optimum growth. Ammonium concentration is less important. (Doria-PTT) W91-11452

GEOGRAPHICAL AND POLLENANALYTICAL RESEARCH OF LAKE KLEINER BARSCH-SEE (BEZ. POTSDAM, GDR) (GEOGRAPHISCHE UND POLLENANALYTISCHE UNTERSU-CHUNGEN DES KLEINEN BARSCH-SEES)
(BEZ. POTSDAM, DDR).

Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie

telle 1 netapue. L. Krey, and K. Kloss. Limnologica LMNOA8, Vol. 21, No. 1, p 117-123, October 1990. 4 fig, 1 tab, 22 ref. English summa-

Descriptors: \*Dating, \*Geography, \*Kleiner Barsch-See, \*Limnology, \*Paleolimnology, \*Paly-nology, \*Pollen, Color, Evaporation, Germany, Glaciation, Hydrologic budget, Ice, Lakes, Mor-aines, Profiles, Rainfall, Sediments, Water level.

Lake Kleiner Barsch-See, a kettlehole-like basin Lake Kienier barkin-see, a kettenlori-ike usain situated within an undrained hollow between the terminal moraines of the Furstenberger and Frank-furter Staffel (Potsdam District, Germany) was formed after the Weichselian stage of the last glaciation. A small oval depression first originated from a melting dead-ice block, eventually creating a lake which now has an area of about 0.3 ha. Its actual water level is 60 m above sea level (asl); the moraines reach 65-75 m asl. Surface inflows and effluents are absent. Rainfall and evaporation compensate each other. Sediment cores of about 6 m pensate each other. Seathneth cores or about of more taken from ice using a modified Livingstone sediment sampler. The sediment color ranged from black to olive brown and olive green with the exception of a small whitish core around 936 cm below water level. This core is identical to the so-called Laach Tephra, dated more than 11,000 years BP. The pollen profile showed a gap between 10,000 and 8,000 years BP. It was concluded that the lake was formed more than 12,000 years BP. (Author's abstract) W91-11514

HISTORY OF CLADOCERA IN THE KLEINER HISTORY OF CLADOCERA IN THE ALEINER
BARSCH-SEE, AN ACIDIC, CALCIUM-POOR,
MARSHY POND IN THE MIDDLE EUROPEAN FLATLAND (DIE GESCHICHTE DER CLADOCERENFAUNA DES KLEINEN BARSCHSEES, EINES SAUREN, KALKARMEN MOORWEIHERS FLACHLAND).

Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.

D. Flossner. Limnologica LMNOA8, Vol. 21, No. 1, p 125-135, October 1990. 3 fig, 2 tab, 47 ref. English summa-

Descriptors: \*Acid lakes, \*Acid rain, \*Calcium, \*Eutrophication, \*Kleiner Barsch-See, \*Lake acidification, \*Limnology, \*Paleolimnology, \*Waterfleas, \*Wetlands, Acidity, Agriculture, Ecosystems, Germany, Glaciation, History, Hydrogen ion concentration, Lake sediments, Mosses, Plankton, Population dynamics, Species composition, Species diversity, Water level.

The distribution of subfossil remains of Cladocera a sediment core from the acid Kleiner Barsch-See (northern East Germany) was examined. A total of 35 species was recorded: 10 non-chydorids and 25 chydorids. Analysis of the cladoceran disand 25 chydorids. Analysis of the cladoceran dis-tribution was based on dominance of the species diversity and equitability. The developmental his-tory of the lake can be divided into three phases. The first period, during late glacial time, was char-acterized by a well developed plankton fauna, dominated by Bosmina langirostris. During the transition from late glacial to postglacial time, the lake changed by in-filling the basin. Chydorids increased in abundance, primary production shifted from phytolankton to macrophytes. The last from phytoplankton to macrophytes. The last phase spaned all of postglacial time, and was charphase spaned all of postglacial time, and was characterized by an increasing abundance of macrophytes (especially water mosses) decreasing pH and calcium content of the water, and a cumulative deposition of organic sediment in the shallow pond. The process of acidification was dependent on the lake level, with increasing acidification during wet periods and decreasing acidification during dry periods. Species diversity decreased with increasing acidity. The reappearance of B. longirostris in postglacial time indicate eutrophication of the water as a result of increased agricultural development during the Bronze Age and early al development during the Bronze Age and early Middle Ages. (Author's abstract) W91-11515

ANALYSIS OF SUBFOSSIL SHELLED PROTO-ZOA IN THE SEDIMENTS OF A SMALL ACID FOREST LAKE (KLEINER BARSCH-SEE, NORTHERN GDR) (ANALYSE SUBFOSSILER PROTOZOENSCHALEN DER SEDIMENTE EINES KLEINEN SAUREN WALDSEES) (KLEINER BARSCH-SEE, NORDLICHE DDR). Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.

Limnologica LMNOA8, Vol. 21, No. 1, p 137-145, October 1990. 11 fig, 4 tab, 19 ref. English summa-

Descriptors: \*Acid lakes, \*Acidification, \*Fossils, \*Kleiner Barsch-See, \*Lake sediments, \*Limnolo-

Lakes-Group 2H

gy, \*Paleolimnology, \*Protozoa, \*Species composition, Chemical composition, Population dynamics, X-rays.

A core (620 cm) from the sediment of a small acid forest lake (Kleiner Barsch-See, northern East Germany), was investigated for its content of subfossil shells of protozoa, and was found to contain 31 species of Testacea and 1 ciliate (Codonella cratera). The most abundant species was Centropyxis aculeata; durability of shells was poor. X-ray microanalysis to compare the chemical composition of subfossil and recent shells yielded contradictory results; a discontinuous size polymorphism of shells was observed for a few species. Recent dictory results; a discontinuous size polymorphism of shells was observed for a few species. Recent and subfossil populations were compared, with shells of Difflugia oblonga and D. globulosa showing favored size classes. Recent and subfossil size peaks had an insignificant shift. Centropyxis aculeata (and therefore C. hirsuta) was found to be too variable in size to be useful in the study. However, in the course of development of the lake, C. aculeata indicated only one main size class surroundleata indicated only one main size class, surrounded by subsidiary classes. Recently investigated populations of C. aculeata did not possess a fapopulations of c. acuteata un not possess a la-vored size class. In the course of development of the lake, C. aculeata also formed temporal races of short duration. Other interesting species found in the area included C. nauwercki and D. kabylica. (Doria-PTT) W91-11516

DIATOM ANALYSIS, LATE-GLACIAL AND POST-GLACIAL DEVELOPMENT OF LAKE KLEINER BARSCH-SEE (GDR)--A PRELIMI-

NARY NOTE.

Akademie der Wissenschaften der DDR, Jena.

Zentralinstitut fuer Mikrobiologie und Experimen-

Etlle Therapie. S. J. Casper, and W. Scheffler. Limnologica LMNOA8, Vol. 21, No. 1, p 147-155, October 1990. 3 fig. 1 tab, 16 ref.

Descriptors: \*Acidification, \*Diatoms, \*Glacia-tion, \*Kleiner Barsch-See, \*Lake acidification, \*Paleolimnology, \*Stratigraphy, Acid lakes, Acidic lakes, Germany, History, Hydrogen ion concentration, Peat, Population dynamics, Silica, Water level, Water level fluctuations.

Post-deglaciation changes in lake water level and pH were investigated in the Kleiner Barsch-See, a small acid forest lake in East Germany, by means small acid forest lake in East Germany, by means of diatom stratigraphy. Diatom development in the lake showed two distinct phases during the late glacial and postglacial period. Diatoms found in the lowermost samples (diatom zones 1 and 2; Late glacial) indicate a slightly alkaline to circumneutral state of the juvenile lake, along with with a well developed pelagic zone and a fairly high water level. An increased dominance of Fragilaria spp. in cone 2; indicates the initial lowering of the water. level. An increased dominance of Fragilaria spp. in zone 2 indicates the initial lowering of the water level. A relatively abrupt change in material at about 880 cm may be due to the lowering of the water level when overgrowth of the lake led to peat formation and acidification, a process which lasted through the whole Postglacial period. Extremely small numbers of diatoms were found. The topmost 9 cm of the core reflect a better (aerial) nutrient supply and possible acidification during the past 20 years. The two main phases in diatom development described are well known from investigations of similar lakes in northern Europe and trigations of similar lakes in northern Europe and America, and are in good agreement with results from biosilica analysis. (Doria-PTT) W91-11517

CHEMICAL COMPOSITION OF LATE- AND POST-GLACIAL SEDIMENTS (FE, MN, P, C, N, N, H AND BSD IN LAKE KLEINER BARSCHSEE, A BOG LAKE IN THE NORTH OF GODE (DIE CHEMISCHE ZUSAMMENSETZUNG DER SPAT- UND POSTGLAZIALSEDIMENTE DES KLEINEN BARSCH-SEES (FE, MN, P, C, N, H UND BSD, EINES DYSTROPHEN MOORWEIHERS IM NORDEN DER DDR).

Akademie der Wissenschaften der DDR, Jena Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.

G. Proft, and L. Krey. Limnologica LMNOA8, Vol. 21, No. 1, p 157-164,

October 1990. 9 fig, 3 tab, 32 ref. English summa-

Descriptors: \*Acid lakes, \*Chemical composition, \*Kleiner Barsch-See, \*Lake sediments, \*Limnology, \*Paleolimnology, \*Stratigraphy, Bogs, Calcium carbonate, Carbon, Environmental chemistry, Germany, Groundwater, Hardness, Hydrogen, Iron, Litter, Manganese, Moisture content, Nitrogen, Phosphorus, Silica.

Stratigraphic investigation of the Kleiner Barsch-See, a small acid forest lake in Germany, revealed two distinct series of Late Glacial and Postglacial sediments. The lower, older sediments (8500-950 cm beneath the water surface) have a low water content (72%) and up to 12% CaCO3, and are rich cm oeneant me water surface; have a low water content (72%) and up to 12% CaCO3, and are rich in iron (14%), manganese (0.6%), and phosphorus (1.05%); biosilica content averaged 20 mg Si/g dry residue (geogenic phase). The layer above this one has a high water content (96.4%), is carbonate-free and poor in Fe (0.23%), Mn (0.041%), P (0.05%), and biosilica (0.8 mg Si/g dry residue). The C/N ratio averages 12.5, indicating Dy-sediment (ombrogenic phase). The lower layers (S2) are autochthonous sediments of a postglacial hard-water lake enriched with elements (Fe, Mn, P, and biosilica) transported from the drainage area. As the waters became sealed off from groundwater and the supply of elements diminished, the water became electrolyte-poor, and the character and chamged. The upper layers (S1) are composed of biogenic peaty plant material of predominantly allochthonous origin from the shore and litter from the surrounding woods. (Doria-PTT) the surrounding woods. (Doria-PTT)

MICROZOOBENTHOS OF THE RIVER JIH-LAVA AFTER THE CONSTRUCTION OF THE DALESICE WATERWORKS,

Brno Univ. (Czechoslovakia). Dept. of Biology. For primary bibliographic entry see Field 6G. W91-11521

IDENTITY OF SUSPENDED PARTICLES IN A CALCITE-DEPOSITING STREAM AND THEIR SIGNIFICANCE IN TRAPPING AND BINDING PHENOMENA.

King's Coll., London (England). Div. of Biosphere Sciences.

For primary bibliographic entry see Field 2E. W91-11522

FISH FAUNA OF VARIOUS BODIES OF STAGNANT WATER NEAR CONCEPCION (PARAGUAY) (ZUR FISCHFAUNA EINIGER STEHENDER GEWASSER BEI CONCEPCION (PARAGUAY)).

Kiel Univ. (Germany, F.R.). Zoologisches Inst.

R. Brinkmann, and K. Bottger. Limnologica LMNOA8, Vol. 21, No. 1, p 257-261, October 1990. 4 fig, 2 tab, 11 ref. English summa-

Descriptors: \*Concepcion, \*Fish, \*Species composition, \*Stagnant water, Cattle, Ecological distribution, Floating plants, Limnology, Macrophytes, Paraguay, Population dynamics, Shallow water.

Zoological and limnological studies were carried Zoological and limnological studies were carried out in one shallow lake and 4 perennating pools (known as tajamares) near Concepcion, Paraguay. Eighteen species belonging to 9 families were netted. The largest number of species (13) were found in the shallow lake, and the smallest (3) from pool number 3, which has steep banks and a limited quality of macrophytes. The pool of the greatest number of species (7) was pool number 2, which is protected from cattle damage and has extensive stands of floating plants. No one species was found in all bodies of water studied. The most widely distributed were Pyrrhulina brevis and Cichlasoma in all bodies of water studied. The most widerly distributed were Pyrrhulian brevis and Cichlasoma dimerus, each of which was found in 4 of the 5 water bodies. Of the 13 species found in the shallow lake, 8 were not found in the pools. (Dorialous Lake, 8 were not found in the pools.) PTT) W91-11523

HYDROBIOLOGICAL SURVEY OF THE CHANOMI CREEK SYSTEM, LOWER NIGER DELTA, NIGERIA. PORT Has-HYDROBIOLOGICAL

Port Harcourt Univ. (Nigeria). Dept. of Zoology. For primary bibliographic entry see Field 5C. W91-11524

LOCAL AND SEASONAL VARIATION OF THE EPIPELIC ALGAE IN SAMARRA IMPOUNDMENT, IRAQ.

Iraq Atomic Energy Commission, Baghdad. A. W. Sabri.

Limnologica LMNOA8, Vol. 21, No. 1, p 275-279, October 1990. 2 fig, 3 tab, 25 ref.

Descriptors: \*Algal growth, \*Limnology, \*Reservoirs, \*Samarra Reservoir, \*Species composition, Algal blooms, Benthic environment, Chlorophyll a, Cyanophyta, Diatoms, Iraq, Limiting nutrients, Phosphates, Phosphorus, Population density, Seasonal variation, Silicates.

The epipelic algal populations in the Samarra Impoundment (Iraq) were studied seasonally during 1987 and 1988. A total of 78 taxa were identified, 1987 and 1988. A total of 78 taxa were identified, with diatoms the dominant group represented by 73 taxa, mostly of the pennate type. Summer and autumn were found to be the best growth season when most taxa were present. Cyclotella ocellata was the dominant species (in quantity) in the pool region, while no clear dominance appeared at other stations. Chlorophyta and Myxophyta (Cyanophyta) were occasionally recorded in low densities only during summer and autumn. Phosphate ranged from 0.003 to 0.039 mg/L. Lower values were reported during winter and spring phate ranged from 0.003 to 0.039 mg/L. Lower values were reported during winter and spring indicating the possibility that phosphorus is a limiting factor for algal growth. Silicates were recorded in concentrations sufficient for algal growth (>1 mg/L), however, during winter there values were very low at one station. especially during winter. This agrees with the known general sequence of silicate depletion after algal bloom. The content of sediment as estimated quence of sincate depiction after again bloom. In organic matter contents of sediment, as estimated in April, had values ranging from 116.72 to 190.89 mg/g. The maximum chlorophyll a content was 3.42 mg/m, correlating closely with mean total cell counts. This reflect the fact that diatoms were the main contributors to chlorophyll a at all of the stations. It was concluded that the recruitment of planktonic species into benthic habitats is an important factor affecting floral composition in epipelic algal communities. (Doria-PTT)
W91-11525

IMPACT OF PHYSICO-CHEMICAL COM-PLEXES ON PLANKTON DENSITY IN DHIR BEEL OF ASSAM.

Gauhati Univ. (India). Dept. of Zoology. Galinari Ginv., Initials, pept. of 2000gy. Y. S. Yavada, and S. C. Dey. Limnologica LMNOA8, Vol. 21, No. 1, p 287-292, October 1990. 1 fig, 10 tab, 19 ref.

Descriptors: \*Dhir Beel (lake), \*Lake ecology, \*Limnology, \*Plankton, \*Population density, \*Water properties, Ammonia, Calcium, Chemical properties, Dissolved oxygen, Dissolved solids, Hydrogen ion concentration, India, Iron, Nitrogen, Phosphorus, Physical properties, Regression analysis, Seasonal variation, Silicates, Statistical analysis.

Multivariate analysis was used to study the impact of physical and chemical conditions on plankton density in Dhir Beel, a riverine lake in Assam (India). It was found that 10 variables explained India). It was found that 10 variables explained 61% of the variation when plankton densities, at different levels, are not considered separately. However, the multiple correlation coefficient (R) increased significantly when levels were treated separately (17 variables accounted for the 94% variation at the surface, while 8 explained the 67% variation at the bottom). These findings, indicate that multiple variation interaction can better explain the variation in plankton density at separate levels. The regression equation (RE) of all three analyses showed that dissolved oxygen (surface and bottom), ammonia-nitrogen (surface), SiO2 (bottom), and month (July) correlate best with plankton density, giving and exponential fit. pH (bottom), iron (bottom), phosphorus (bottom), and

#### Group 2H-Lakes

level (bottom level) were significant when levels are combined; Fe (bottom), Ca (surface), P (bottom), SiO2 (surface), dissolved organic matter (surface), month (February to July), and horizontal sector are significant at the surface level; and pH (surface) and P (surface) at the bottom level. The contraces and resultance at the contoin even the appearance of level and sector in the combined RE indicates a variation in plankton density on both vertical and horizontal planes in the Beel. Results justify the deletion of insignificant factors from physicochemical studies to increase the efficiency of data collection. (Doria-PTT)

SEASONAL VARIATIONS AND RELATION-SHIPS OF DIFFERENT PHYSICO-CHEMICAL CHARACTERISTICS IN NEWLY MADE TAWA

Government Home Science Coll., Hoshangabad Government Home Science Coll., Hosnangabad (India). Dept. of Zoology. S. Singhal, G. M. A. Ramani, and U. S. Gupta. Limnologica LMNOA8, Vol. 21, No. 1, p 293-301, October 1990. 17 fig, 2 tab, 30 ref.

Descriptors: \*India, \*Limnology, \*Reservoirs, \*Water properties, Alkalinity, Analysis of variance, Bicarbonates, Calcium, Carbon dioxide, Carbonates, Chemical properties, Chlorides, Dissolved oxygen, Hardness, Hydrogen ion concentration, Littoral zone, Nitrates, Oligotrophy, Phosphates, Physical properties, Seasonal variation, Statistical analysis, Sulfates, Temperature, Transparency, Water temperature

Water temperature.

Montly and seasonal variations of different physicochemical characteristics in the Tawa Reservoir, Madhya Pradesh, India, were evaluated at three stations (2 littoral and 1 limnetic) with three levels (surface, middle, and bottom). Correlation coefficients were calculated between 17 pairs of varia-bles to construct correlation matrices. The minimum value of Secchi transparency was observed during the rainy season. A direct relationship was found between air and water temperature, and between pH and water temperature during the between pH and water temperature during the summer season, the last relationship due to the the behavior of phytoplanktonic gross primary productivity, Generally, water in the Tawa Reservoir remained alkaline because of the abundance of buffering substances (rain water and carbonates). High values of free CO2 were recorded in the monsoon period, attributable to the decreased availability of sunlight. High O2 concentrations were recorded in late winter and early summer, while low values were recorded in the rainy while low values were recorded in the rainy season. The low values of O2 during this season may be due to a heavy influx of waters, resulting in poor photosynthesis. Dissolved oxygen (DO) was positively correlated with pH during rainy and winter seasons, and negatively correlated with bicarbonates. The analysis of variance for chloride carbonates. The analysis of variance for chloride was significant with season; chloride concentration varied between 12-40 ppm, showing the oligotrophic nature of the reservoir. Sulfate values were recorded between 19 and 5.7 ppm. No clear seasonal trend was found, although sulfates were positively correlated with phosphate during the rainy and winter season. Values of phosphate ranged between a low of 0.060 ppm and a high of 0.098 ppm. The values remained nearly constant throughout all of the seasons. Values of nitrate during rains were higher than in other seasons, due primarily to the addition of nitrates into the reservoir from runoff water. (Doria-PTT) W91-11528 W91-11528

HABITAT USE BY AN ASSEMBLAGE OF FISH IN A LARGE WARMWATER STREAM. Virginia Polytechnic Inst. and State Univ., Blacks-burg. Dept. of Fisheries and Wildlife Sciences.

burg. Dept. of Fisheries and M. D. Lobb, and D. J. Orth.
Transactions of the American Fisheries Society
TAFSAI, Vol. 120, No. 1, p 65-78, January 1991. 2 fig, 4 tab, 44 ref.

Descriptors: "Aquatic habitats, "Ecological distribution, "Fish management, "Stream biota, Bass, Benthic fauna, Bluestone Dam, Channels, Flow, Growth stages, Habitat restoration, Macroinvertebrates, Macrophytes, Minnows, New River, Population density, Powerplants, Productivity, Riffles,

Shallow water, Species composition, West Virgin-

The New River is a sixth-order warmwater stream in southern West Virginia. Habitat use patterns were examined in a fish assemblage in a 60-400 m wide reach of the river. Fish species and life stage composition and densities differed among habitat composition and densities differed among national types, and five habitat-use guilds were proposed: edge pool, middle pool, edge channel, riffle, and generalist. Larger centrarchids used deep habitats with slow velocities, whereas young centrarchids used shallower habitat. Juvenile and adult smallmouth bass Micropterus dolomieui were nearly ubiquitous in the habitats of the study area, although densities were highest among snags. Min-nows and darters used shallower areas, but the range of velocity used differed among species and life stages. Vegetated and channel edge habitats served as nursery areas. Total fish densities were highest in edge pool, backwaters, snags, edge rifles, and rifles. Nearshore, structurally complex habitats seem important in influencing the assemblage structure of fishes of large streams. Proposed peaking power operations at Bluestone Dam may affect standing stocks of benthic macroinvertebrates in the New River through erosion of macrophytes. The productivity of many fish could also be adversely affected because of the reduction of macroinvertebrate prey and the loss of emergent and submerged vegetation. Finally, the association range of velocity used differed among species and macroinverteorate prey and the loss of emergent and submerged vegetation. Finally, the association of the sport fish with the rare snag habitats sug-gests the potential value of habitat improvement with natural materials. (Author's abstract) W91-11533

DISTRIBUTION, HABITAT USE, AND GROWTH OF AGE-0 COLORADO SQUAW-FISH IN THE GREEN RIVER BASIN, COLO-RADO AND UTAH.
Fish and Wildlife Service, Vernal, UT.

Transactions of the American Fisheries Society TAFSAI, Vol. 120, No. 1, p 79-89, January 1991. 3 fig. 5 tab, 17 ref.

Descriptors: \*Aquatic habitats, \*Ecological distri-bution, \*Fish, \*Growth, \*Squawfish, \*Stream fish-eries, Colorado, Flow, Green River Basin, Growth stages, Larval growth stage, Population density, Sampling, Seasonal variation, Shores, Survival, Temperature, Turbidity, Utah, Water depth.

Age-0 Colorado squawfish Ptychocheilus lucius (N=11,379) were captured as larvae and postlarvae in drift nets and seines in the Green and Yampa rivers from 1979 to 1988. Larvae were captured in drift nets (N=601) for 2-6 weeks in June and July. Small postlarvae (N=3,079) were captured by seining shoreline habitats in July and August. In September and October, postlarvae were most abundant (N=6.459) in low-gradient reaches of the abundant (N=6,459) in low-gradient reaches of the Green River. Catch data indicated that the postlarvae moved from the Yampa and Green river spawning areas and were concentrated about 150 km downstream by autumn of each year. Spring sampling indicated that young fish (N=1,240) overwintered in areas occupied the previous autumn. Postlarvae captured in the Green River autumn. Postlarvae captured in the Green River (N=5,043) most frequently occupied shoreline embayments (backwaters) that were relatively warm (mean, 17.0 C), deep (mean, 38 cm), large (mean, 826 sq m), and turbid. Abundance and size of young Colorado squawfish in the Green River were inversely correlated with high summer and autumn flows, which inundated nursery habitats. Seine catches of young squawfish in 4 years of sampling the upper and lower Green River in autumn and the following spring were not reliable in assessing overwintering mortality of age-0 Colorado squawfish, presumably due to differences in capture vulnerability between seasons. Survival of small fish in spring indicated their tolerance of prevailing winter conditions. (Author's abstract) W91-11534

SHORT-TERM EFFECTS OF A CATASTROPHIC BEAVER DAM COLLAPSE ON A STREAM FISH COMMUNITY.

North Dakota Univ., Grand Forks. Dept. of Biol-

For primary bibliographic entry see Field 2E. W91-11558

MODELS OF SEASONAL GROWTH OF THE EQUATORIAL CARP LABEO DUSSUMIERI IN RESPONSE TO THE RIVER FLOOD CYCLE.

Colombo Univ. (Sri Lanka). Dept. of Zoology. M. A. K. Smith.

Environmental Biology of Fishes EBFID3, Vol. 31, No. 2, p 157-170, June 1991. 8 fig, 5 tab, 42 ref.

Descriptors: "Model studies, "Floods, "Stream fisheries, "River flow, "Carp, "Seasonal variation, "Mahaweli Ganga, Sri Lanka, Monsoon, Flood peak, Fish growth, Temperature, Hydrogen ion concentration, Light intensity, Conductivity,

The phenology of Labeo dussumieri, an omnivorous carp common to South Asia, was investigated in a population inhabiting a flood plain anabranch of the Mahaweli Ganga, Sri Lanka. The Mahaweli Ganga exhibited a bimodal discharge pattern typical of many equatorial rivers, with a minor peak during the S.W. monsoon and a major peak during the N.E. Monsoon. Seasonal changes in several losts variables water measured in a attempt to lotic variables were measured in an attempt to correlate changes in environmental conditions to reproduction and growth in L. dussumieri. The onset of gonad recrudescence and spawning were onset of gonad recrudescence and spawning were synchronized with the increased river discharge during the S.W. and N.E. monsoons: gonad development followed one monsoonal discharge peak and spawning took place at the beginning of the other. Most fish spawned at the beginning of the major discharge peak in October and November, following the September dry season. Growth was shown to be seasonal, exhibiting an annual bimodal nattern with peaks coincident with S.W. and N.E. shown to be seasonal, exhibiting an annual bimodal pattern with peaks coincident with S.W. and N.E. monsoonal rains. Seasonal changes in growth were expressed by two models in terms of: (1) change of somatic weight or fork length with time, and (2) change of specific growth rate in response to river discharge, modified by somatic weight. Gonad recrudescence and spawning stress did not appear to influence growth rate. (Author's abstract) W91-11559

DRIFT OF THE CHARACIN LARVAE, BRY-CONAMERICUS DEUTERODONOIDES, DURING THE DRY SEASON FROM ANDEAN PIEDMONT STREAMS.

Maryland Univ., College Park. Dept. of Zoology. A. S. Flecker, D. C. Taphorn, J. A. Lovell, and B. P. Feifarek.

Environmental Biology of Fishes EBFID3, Vol. 31, No. 2, p 197-202, June 1991. 3 fig, 24 ref.

Descriptors: \*Fish larvae, \*Stream fisheries, \*Streamflow, \*Tropical regions, Diurnal variation, Larvae, Characids.

The downstream transport of fish larvae is well known from temperate running waters, but there exists remarkably little information for tropical exists remarkably little information for tropical streams. Drift in two Andean piedmont streams was sampled during the dry seasons of 1986-1988. Bryconamericus deuterodonoides (Characidae) larvae were found to be extremely abundant in larvae were tound to be extremely abundant in some drift collections, with peak drift densities exceeding those of temperate streams by as much as an order of magnitude. Drift of fish larvae displayed pronounced diel periodicity, with more than one-quarter of a million larvae collected during the night compared to two individuals during the day. Fish larvae were more abundant during the day. rsn inavae were more aduntant during the latter compared to early part of the dry season, even in years when streams were reduced to small isolated pools by the end of the season. These observations indicate that the dry season represents an important period of reproduction for the characid, B. deuterodonoides, and possibly other neotropical fish species. (Author's abstract)

REVIEW OF FISHERIES HABITAT IMPROVE-MENT PROJECTS IN WARMWATER

# Water In Plants—Group 21

STREAMS, WITH RECOMMENDATIONS FOR WISCONSIN.

Wisconsin Dept. of Natural Resources, Madison. Bureau of Fish Management.

J. Lyons, and C. C. Courtney.

Wisconsin Department of Natural Resources
Technical Bulletin No. 169, 1990. 34p, 9 fig, 42 ref,
3 append.

Descriptors: \*Channel improvement, \*Fisheries, \*Habitat improvement, \*Habitat restoration, \*Literature review, \*Water resources management, \*Wisconsin, Bank stabilization, Environmental pollution, Erosion control, Streams, Water temperature. Watersheds.

Over 100 publications and unpublished reports, over 30 fisheries biologists from 20 universities and natural resource management agencies, and made on-site observations of projects in Illinois and Missouri were reviewed to determine what is currentify (early 1989) known about physical habitat improvement for fisheries in warmwater streams. Previous improvement work has focused on 3 main objectives: reducing bank erosion and in-stream sediment, modifying channel morphology and alignment, and increasing in-stream cover. A wide variety of techniques appear to be useful in achieving these objectives, although few have been adequately evaluated. Based on these reviews, contacts, and observations, the following general recommendations for warm water stream habitat improvement projects in Wisconsin can be made: (1) consider the entire stream ecosystem and watershed when planning projects, and try to address fundamental underlying causes of habitat problems whenever possible; (2) before beginning a project, collect quantitative data that demonstrate a need for habitat improvement and indicate probably limiting habitat characteristics; (3) use the most cost-effective techniques to improve habitat, and rely on natural objects or simple, easily replaced structures whenever possible; (4) use all available data and expertise in determining the proper placement and installation of habitat improvement. For warm water streams in Wisconsin, the authors believe that bank revegetation coupled with the judicious use of riprap is the best approach to bank stabilization. Careful placement of boulders, trees, and rock wing dams should be effective in reducing sedimentation and increasing channel depth. Stable banks and deeper channels will improve in-stream cover. If further increases in cover are warranted, the placement of additional rocks and logs or the installation of habitaring the proper placement of additional rocks and logs or the installation of habitaring the proper placement of additional rocks and logs or the installatio

ASSESSING THE RESPONSE OF EMERALD LAKE, AN ALPINE WATERSHED IN SEQUOIA NATIONAL PARK, CALIFORNIA, TO ACIDIFICATION DURING SNOWMELT BY USING A SIMPLE HYDROCHEMICAL MODEL.

Geological Survey, Doraville, GA. Water Resources Div.

For primary bibliographic entry see Field 5C. W91-11594

# HYDROLOGIC CHARACTERISTICS OF THE GREAT SALT LAKE, UTAH: 1847-1986.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2332, 1990. 32p, 28 fig, 3 tab, 47 ref, 1 map.

Descriptors: \*Great Salt Lake, \*Limnology, \*Utah, \*Water level, Algae, Arid lands, Ecosystems, Land use, Salinity, Species diversity.

The Great Salt Lake in Utah is a large body of water bordered on the west by barren desert and on the east by a major metropolitan area. It is the fourth largest terminal lake in the world, covering about 2,300 sq m in 1986. Since its historic low elevation of 4,191.35 ft in 1963, the lake rose to a new historic high elevation of 4,211.85 ft in 1986.

Most of the increase (12.2 ft occurred after 1982). The rise has caused \$285 million of damage to lake side industries, transportation, farming, and wild-life. Accompanying the rapid rise in lake level has been a decrease in salinity-from 28% in 1963 to about 6% in 1986. This has resulted in changes in the biota of the lake from obligate halophiles, to opportunistic forms, such as blue-green algae and most recently, a brackish water fish. (Author's abstract)

#### 2I. Water In Plants

MICROCLIMATOLOGICAL INVESTIGA-TIONS IN THE TROPICAL ALPINE SCRUB OF MAUI, HAWAII: EVIDENCE FOR A DROUGHT-INDUCED ALPINE TIMBERLINE. Goettingen Univ. (Germany, F.R.). Systematisch-Gebotanisches Inst. und Neuer Botanischer Garten.

C. Leuschner, and M. Schulte.
Pacific Science PASCAP, Vol. 45, No. 2, p 152-168, April 1991. 7 fig, 3 tab, 64 ref.

Descriptors: \*Climatology, \*Drought effects, \*Hawaii, \*Maui, \*Microclimatology, \*Mountains, \*Plant-water relationships, \*Precipitation, \*Timberline, \*Tropical regions, \*Water availability, Air temperature, Cloud cover, Humidity, Soil temperature, Solar radiation, Wind velocity.

Micrometeorological measurements were made in the lower alpine zone of Mt. Haleakala on Maui, Hawaiian Islands, in March 1988 to characterize ecologically significant climatological parameters. Daily courses of photosynthetically active and total net radiation, temperatures of air, soil, and plant canopy, wind speed, air humidity, leaf wetness, and precipitation were recorded at an elevation of 2100 m in alpine scrub slightly above the timberline. A battery-powered data-logging system was used, which gave high temporal resolution. Influence of variable cloud cover on microclimate of the study site was evaluated on five selected days with highly differing weather conditions. Based on comparison with data from other high mountains of the humid tropical zone, it is concluded that the alpine timberline on Maui is caused by a complex of factors. Plant water availability is probably the dominating one; temperature seems to be of lesser importance. The extraordinary microclimatological conditions of the alpine zone of Maui are examined in the context of the atmospheric circulation system in the region of the Hawaiian archipelago. (Author's abstract) W91-10878

ECOPHYSIOLOGICAL SIGNIFICANCE OF THE DIEL BIOCHEMICAL CHANGES OF PARTICULATES COUPLED WITH METABOL-IC AND ENVIRONMENTAL PARAMETERS IN TWO TROPHICALLY DIFFERENT LAKES.

Clermont-Ferrand-2 Univ., Aubiere (France). Lab. de Zoologie et Protistologie. For primary bibliographic entry see Field 2H. W91-10896

RAINFALL INTERCEPTION AND BOUNDARY LAYER CONDUCTANCE IN RELATION TO TREE SPACING.

Edinburgh Univ. (Scotland). Dept. of Forestry and Natural Resources.

Z. Teklehaimanot, P. G. Jarvis, and D. C. Ledger.
Journal of Hydrology JHYDA7, Vol. 123, No. 3/
4, p 261-278, March 1991. 8 fig, 6 tab, 26 ref.

Journal of Hydrology JHTDA7, vol. 25, No. 37, 4, p 261-278, March 1991. 8 fig. 6 tab, 26 ref. Descriptors: \*Boundary layers, \*Conductance, \*Forest hydrology, \*Interception, \*Precipitation, \*Throughfall, \*Trees, Evaporation, Interception loss, Penman equation, Spruce trees, Stemflow.

The effect of tree spacing on rainfall interception loss has been investigated in stands of Sitka spruce (Picca sitchensis (Bong.) Carr) spaced at intervals of 2, 4, 6, and 8 m. The traditional volume balance method was used to measure throughfall, stemflow and interception loss between the four interception loss between the four

spacing treatments was analyzed. The variation of results obtained showed that, on average, annual interception loss as a percentage of gross rainfall was 33, 24, 15 and 9% in the 2, 4, 6, and 8m spacing treatments, respectively. An estimate of average boundary layer conductance was made by equating interception loss with evaporation rate and inverting a truncated form of the Penman equation. The boundary layer conductance per tree increased with spacing from 0.38 cu-m/s in the 2 m spacing treatment to 4.24 cu-m/s in the 8 m spacing treatment, whereas boundary layer conductance per unit area declined from 0.17 to 0.07 m/s as the density of trees decreased. The difference in interception loss between spacing treatments was attributed to the difference in the boundary layer conductance. (Author's abstract) W91-10905

OZONE, ACIDIC PRECIPITATION, AND SOIL MG EFFECTS ON GROWTH AND NUTRITION OF LOBLOLLY PINE SEEDLINGS.

Tennessee Valley Authority, Norris. Cooperative Forest Studies Program.

For primary bibliographic entry see Field 5C. W91-10918

EFFECTS OF DROUGHT STRESS AND SIMULATED ACIDIC RAIN ON FOLIAR CONDUCTANCE OF ZEA MAYS L.

Pennsylvania State Univ., University Park. Dept. of Plant Pathology.
For primary bibliographic entry see Field 5C.
W91-10919

TREE-RING RECONSTRUCTED SUNSHINE DURATION OVER CENTRAL USA.

Arkansas Univ., Fayetteville.
D. W. Stahle, M. K. Cleaveland, and R. S.

Cerveny. International Journal of Climatology IJCLEU, Vol. 11, No. 3, p 285-295, April 1991. 3 fig, 2 tab, 36 ref. National Science Foundation Climate Dynamics Program grant nos. ATM-8412912, ATM-8612343, and ATM-8914561.

Descriptors: \*Climatic data, \*Climatology, \*Plant growth, \*Precipitation, \*Trees, \*Water stress, Baldcypress trees, Cloud cover, Correlation analysis, Dendrochronology, El Nino/Southern Oscillation, Oak trees, Plant water potential.

Tree-ring chronologies of baldcypress (Taxodium distichum) and post oak (Quercus stellata) from the central U.S. are directly correlated with precipitation, and inversely with percentage possible sunshine during the growing season (March-June). Partial correlation analysis indicates that precipitation is the most important climate signal in the growth of these trees, but sunshine duration accounts for an additional 22% of the radial growth variance independently of the growth influences of precipitation or temperature. Because the internal moisture balance of trees and ultimately the width of annual tree-rings assimilate the direct and interactive effects of sunshine duration, temperature, and especially precipitation, the tree-ring fronology can explain 60% of the variance in regional sunshine duration. Consequently, the derived reconstruction retains more sunshine duration information than is reflected by the simple covariance between rainfall, cloud cover, and sunshine. A tree-ring reconstruction of sunshine duration from AD 1700 to AD 1980 suggest that short-period changes in the mean, variance, and persistence of cloud cover have occurred over the past 281 years. Analysis of the reconstruction indicates that strong El Nino events are often associated with cloudy growing season conditions over the central U.S. The full 281-year reconstruction and the 85-year instrumental sunshine data also contain prominent 5 to 10-year sunshine oscillations, which frequently help to induce trends lasting up to 20 years. The sunshine reconstruction does not, however, reveal any statistically significant 30-year-long linear trends in sunshine duration since 1700. (Author's abstract)

#### Group 21-Water In Plants

MICROWAVE TRANSMISSION, A NEW TOOL IN FOREST HYDROLOGICAL RESEARCH. Amsterdam Univ. (Netherlands). Lab. for Physical Geography and Soil Science. W. Bouten, P. J. F. Swart, and E. De Water. Journal of Hydrology JHYDA7, Vol. 124, No. 1/ 2, p 119-130, April 1991. 6 fig, 28 ref.

Descriptors: \*Evaporation, \*Forest hydrology, \*Instrumentation, \*Interception, \*Microwaves, \*Plant-water relationships, \*Throughfall, Analytical models, Automation, Canopy, Fir trees, Forest watersheds, Hydrologic models, Precipitation, The Netherlands, Water storage.

After several decades of interception studies, there are still considerable gaps in the understanding of wet-canopy evaporation. Model development is wet-canopy evaporation. Model development is being obstructed by the lack of techniques for the measurement of state and rate variables which have to be quantified for model validation. The applicability of microwave attenuation measure-ments for the determination of canopy wetness was examined. The attenuation caused by a single spruce fir in the laboratory and the vertical attenu-ation profiles of a Douglas fir stand were measured under dry and wet conditions. The results indicate increase of the attenuation upon wetting and a under dry and wet conditions. The results indicate increase of the attenuation upon wetting and a decrease owing to drip and evaporation after rainfall ceased. From the results, conclusions have been drawn on the design of instrumentation for an optimized measuring system which is suitable for unattended automated scanning of canopy water storage. This system has been calibrated, using sesticible in several account. storage. In system has been childraced, using vertically integrated microwave attenuation profiles and canopy water budgets from precipitation and throughfall measurements. This system will be used for a forest hydrological study in the framework of the Dutch ACIFORN project, a research project on the effect of atmospheric deposition on Douglas fir vitality. (Author's abstract)

RAINFALL INTERCEPTION BY TREES OF PINUS RADIATA AND EUCALYPTUS VIMIN-ALIS IN A 1300 MM RAINFALL AREA OF SOUTHEASTERN NEW SOUTH WALES: I GROSS LOSSES AND THEIR VARIABILITY. Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Forest Research.

For primary bibliographic entry see Field 2D. W91-11345

INFLUENCE OF LEAF LEACHATE-EN-RICHED WATER OF NEEM (AZADIRACHTA INDICA A. JUSS) AND SHIRISH (ALBIZZIA LEBBEK BENTH.) ON THE GROWTH OF EICHHORNIA CRASSIPES (MART.) SOLMS. Burdwan Univ. (India). Dept. of Botany. Q. Taheruzzaman, and D. P. Kushari. Aquatic Botany AQBODS, Vol. 40, No. 1, p 1-9, April 1991. 1 fig. 1 tab, 46 ref.

Descriptors: \*Ephemeral streams, \*Neem, \*Plant growth, \*Shirish, \*Water hyacinth, Biocontrol, Biomass, Chlorophyll, Growth, India, Leaching, Leaves, Light effects, Nitrates, Nitrogen, Nutrients, Phosphates, Phosphorus, Salts, Seasonal variation

An experiment was conducted to determine the seasonal effects of water enriched by neem (Azadirachta indica) and shirish (Albizzia lebbek) on the growth of water hyacinth (Eichhornia crassipes) collected from ditches in Burdwan (India). Stocks were cultivated outdoors in concrete tanks containing pond water and sediment with or with-out fresh leaves of the two terrestrial species. Total out fresh leaves of the two terrestrial species. Total soluble salts were greatest in neem-treated water, followed by shirish, in summer. Maximum nitrate mitrogen was recorded in shirish-treated water, followed by neem, in summer. Maximum phosphate phosphorus was noted in neem water, followed by shirish. The rate of change of Eichhornia biomass varied seasonally, but was always far higher in leaf-treated water. The growth of Eichhornia was not sharply affected by shade conditions, although maximum crowth was noted in neem water (75 41). maximum growth was noted in neem water (75.41 g fresh weight) in the open area. Chlorophyll content was always higher in partial shade. The

higher growth rate of Eichhornia in water en-riched with different leaves in different shade conditions may be related to more leaching of nutri-ents from the leaves. The higher growth in neem-enriched water might also be related to the release of some chemical substances that could inhibit the growth of pests and diseases that would otherwise suppress plant growth. (Doria-PTT)
W91-11449

INFLUENCE OF FLOODED SOIL ON CHEMI-CAL COMPOSITION OF ANNUAL RYEGRASS AND DIGESTIBILITY BY MEADOW VOLES. Massey Univ., Palmerston North (New Zealand). T. H. Terrill, V. G. Allen, J. P. Fontenot, J. A. Cranford, and J. G. Foster. Virginia Journal of Science VJSCAI, Vol. 42, No.

Descriptors: \*Chemical composition, \*Flooding, \*Forages, \*Grazing, \*Nutrients, \*Rodents, Absorption, Acidity, Aluminum, Amino acids, Cellulose, Copper, Grasses, Greenhouses, Iron, Magnesium, Minerals, Organic acids, Phosphorus, Soil moisture, Soil types, Zinc.

1, p 101-112, Spring 1991. 5 tab, 31 ref.

Flooding affects mineral composition of pasture grasses, but little is known concerning effects on fiber, organic acid and amino acid composition, fiber, organic acid and amino acid composition, dry matter digestibility, and mineral absorption by animals. 'Gulf' annual ryegrass (Lolium multi-florum) was grown on a Bucks loam (Typic Hapludit, fine-loamy, mixed, mesic) in a greenhouse to investigate the influence of flooding and 80% field investigate the influence of Hooting and sorts mean capacity (FC) soil moisture on plant growth and chemical composition. Flooding increased soil pH, tended to increase soil exchangeable Al (modified aluminon method), and increased Al, Fe, Cu, neuaumnon metrody, and increased Al, re, Cu, neu-tral detergent fiber (NDF), acid detergent fiber (ADF), hemicellulose, alanine, valine, and gluta-mate concentrations in ryegrass herbage. Magnesi-um, K, Zn, malate, fumarate, and succinate conum, K, Zn, malate, fumarate, and succinate con-centrations were decreased by flooding. Meadow voles (Microtus pennsylvanicus) were fed the for-ages grown at two moisture levels over an 8-day period to evaluate mineral availability and forage digestibility. Apparent absorption of Mg and K was decreased in animals fed forage grown on flooded soil, but absorption of Al, Fe, and P tended to increase. Results suggest that forages grown under flooded conditions have altered amino acid, organic acid. mineral. and fiber conamino acid, organic acid, mineral, and fiber con-centrations, which could result in lowered per-formance of animals grazing these forages. (Author's abstract) W91-11536

#### 2J. Erosion and Sedimentation

ADVANCES IN WIND AND WATER EROSION PREDICTION.

Minnesota Univ., St. Paul. Dept. of Agricultural Engineering.

Journal of Soil and Water Conservation JSWCA3, Vol. 46, No. 1, p 27-29, January/February 1991. 2 fig, 22 ref.

Descriptors: \*Computer models, \*Erosion, \*Erosion rates, \*Model studies, \*Universal soil loss equation, \*Wind erosion, Forecasting, Soil erosion, Water Erosion Prediction Project, Wind Erosion

Erosion prediction is a powerful tool used by soil conservationists for almost five decades. Although several erosion equations have been developed, the most popular one by far is the universal soil loss equation (USLE) developed by W. H. Wischmeier for sheet and rill erosion. A similar equation for predicting erosion by wind is the wind erosion equation (WEQ). These equations are used almost exclusively by the Soil Conservation Service and other user agencies. The potential is great for improvements in erosion prediction technology.

The USDA Water Erosion Prediction Project improvements in evosion prediction terminology. The USDA Water Erosion Prediction Project (WEPP) started in 1985 has developed the land-scape profile version of the model and its companion computer program to fulfill the first phase of the project to develop new generation, processbased technology for predicting erosion by water. Whereas the USLE considers only the eroding portion of landscape profile, WEPP technology considers erosional and depositional portions of landscape profiles, ephermeral gullies within the fields, complex flow patterns within fields, and the variation of erosion over complex fields that vary variation of erosion over complex fields that vary in topography, soil, cropping, and management. Even though WEPP is very much process-based, it does not answer all questions. Gaps and areas needing dramatic improvements include: better definition of flow patterns over the soil surface; better model structure to represent these flow pat-terns; improved understanding of erosion processterns; improved understanding of eroson process-es; and improved understanding of how fundamen-tal soil properties affect erodibility and infiltration, especially as these processes are modified by cli-mate, tillage, cropping, and management. (Mertz-PTT W91-10509

RUSLE: REVISED UNIVERSAL SOIL LOSS

Agricultural Research Service, Tucson, AZ. K. G. Renard, G. R. Foster, G. A. Weesies, and J.

Journal of Soil and Water Conservation JSWCA3, Vol. 46, No. 1, p 30-33, January/February 1991. 1 tab, 4 ref.

Descriptors: \*Computer models, \*Erosion, \*Revised Universal Soil Loss Equation, \*Soil erosion, \*Universal soil loss equation, Agricultural practices, Erosion rates, Forecasting, Rill erosion, Slope degradation, Soil conservation.

The Universal Soil Loss Equation (USLE) is a powerful tool that has been used by soil conserva-tionists for almost three decades for on-farm planning of soil conservation practices, inventorying and assessing the regional and national impacts of erosion, and developing and implementing public policy related to soil conservation. A Revised Universal Soil Loss Equation (RUSLE) has been deversal Soil Loss Equation (RUSLE) has been developed over the past three years. Some of the improvements include: a greatly expanded erosivity map for the western U.S.; minor changes in Ractors (input that drives the sheet and rill erosion process) in eastern U.S.; expanded information on soil erodibility; slope length factor that varies with soil susceptibility to rill erosion; a nearly linear slope steepness relationship that reduces computed soil loss values for very steep slopes; a subfactor method for computing values for the cover-management factor; and improved factor values for the agement factor; and improved factor values for the effects of contouring, terracing, striperopping, and management practices for rangeland. RUSLE will be implemented using a computer program that, along with documentation, will be available soon. Differences in soil loss estimates between the RUSLE and USLE vary from more to less erosion for individual locations depending on specific factor value changes. (Mertz-PTT)
W91-10510

WEPP: A NEW GENERATION OF EROSION PREDICTION TECHNOLOGY.

National Soil Erosion Lab., West Lafayette, IN. J. M. Laflen, L. J. Lane, and G. R. Foster.

Journal of Soil and Water Conservation JSWCA3, Vol. 46, No. 1, p 34-38, January/February 1991. 3

Descriptors: \*Computer models, \*Computer programs, \*Erosion, \*Soil erosion, \*Water Erosion Prediction Project, Computers, Erosion rates, Soil conservation, Universal soil loss equation.

The Water Erosion Prediction Project (WEPP) represents a departure from factor-based erosion prediction technology to a new process-based technology. As new studies are conducted and more computer power becomes available, WEPP will provide a basis for inserting improved process descriptions and parameter values that will provide improved technology for prediction of soil erosion. The WEPP effort is a multistep process that included: development of a user-requirements document; evaluation and targeting of critical research to be accomplished before the technology could be

# Erosion and Sedimentation—Group 2J

used; identification of a core team of scientists to produce the various components; development of an operational computer program; development and completion of an implementation plan that and completion of an implementation plan that included validation and testing of the portion of WEPP that computes soil erosion and evaluation and testing of the user-friendly components of the operational computer program. As with the Universal Soil Loss Equation, WEPP is intended to be a living technology that provides the framework for a technology for a long period of time. The power of WEPP holds great promise for addressing important natural resource issues in ways that they need to be addressed but in the past could be they need to be addressed but in the past could not be because of limitations in the predictive technology. (Mertz-PTT) W91-10511

WEPP: SOIL ERODIBILITY EXPERIMENTS FOR RANGELAND AND CROPLAND SOILS. National Soil Erosion Lab., West Lafayette, IN. J. M. Laflen, W. J. Elliot, J. R. Simanton, C. S. Holzhey, and K. D. Kohl. Journal of Soil and Water Conservation JSWCA3, Vol. 46, No. 1, p 39-44, January/February 1991. 10 fig, 1 tab, 20 ref.

Descriptors: \*Computer models, \*Erosion, \*Model studies, \*Rill erosion, \*Soil erosion, \*Water Erosion Prediction Project, Computer programs, Cropland, Range management, Soil transport.

The Water Erosion Prediction Project (WEPP) ombines knowledge of soil erosion processes with other important processes in a simulation model to predict soil erosion by water. WEPP models soil erosion as a process of rill and interill detachment and transport. A study on rangeland and cropland soils has been conducted over much of the U.S. to produce the data base needed to estimate soil erodibility for application of WEPP to the nation's soils. Analyses indicate that the soil erodibility soils. Analyses indicate that the soil erodibility values bear little quantitative resemblance to Universal Soil Loss Equation (USLE) soil erodibility values, but variables important in determining USLE soil erodibility values, such as particle size distribution and organic matter content, may also be important in determining WEPP soil erodibility values. Extremely high erosion rates may occur in rills, particularly if flow rates are high and slopes are fairly steep. Some of these rates are so high that they should be cause for immediate concern. These rates are realistic on freshly tilled soils, and were observed in the WEPP field studies. They were observed in the WEPP field studies. They also were supported by field observations of soil removal in rills and ephermeral gullies. In addition, as surface water quality becomes a greater concern, the use of the WEPP erosion technology to evaluate the chemicals transported in surface runoff will become more important. (Mertz-PTT) W91-10512

FLUIDIZATION OF MARINE MUD BY WAVES.
California Univ., Berkeley. Dept. of Civil Engi-

For primary bibliographic entry see Field 5B. W91-10533

SEDIMENT TRANSPORT ON THE FORE-

SHORE:
Universidad Politecnica de Canarias, Las Palmas de Gran Canaria (Spain). Dept. of Physics.
For primary bibliographic entry see Field 2L.
W91-10599

SCOUR AT CANTILEVERED PIPE OUTLETS, PLUNGE, POOL ENERGY DISSIPATOR DESIGN CRITERIA.

Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab. For primary bibliographic entry see Field 8B. W91-10722

INVESTIGATION OF LOCAL SCOUR IN CO-HESIONLESS SEDIMENTS USING A TUNNEL-MODEL.

Waterloopkundig Lab. te Delft (Netherlands).

M. Buchko, P. Kolkman, and K. Pilarczyk. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-134065. Price codes: A03 in paper copy, A01 in microfiche. Publication No. 393, December 1988. 11p, 7 fig, 2 tab, 5 ref.

Descriptors: \*Erosion, \*Hydraulic models, \*Model studies, \*Scour, \*Tunnels, Flow pattern, Flow velocity, Hydraulic structures, Mathematical studies,

Erosion of soil near hydraulic structures is usually studied in hydraulic models using Froude similitude. With free surface flow, exaggeration of the velocity is used only when the Froude number is small (the water level nearly horizontal). Erodability is not well reproduced with finer grain sizes, and empirical relationships have to be used for extrapolation to prototype. Parameters of interest in the design of hydraulic structures and bottom protection are: rate of scouring, step discontinuities at the upstream end of the scour hole, scour hole slopes, and the equilibrium scour depth. Two-dimensional sand erosion tests in a closed water tunnel (velocities up to 2 m/s) produced a scour hole downstream in a sill or flat bottom protection. The slope of the scour hole was independent of hole downstream in a sill or flat bottom protection. The slope of the scour hole was independent of flow velocity and partially dependent on scale; and wholly dependent on grain size, grain-size gradution, and sill geometry. Tractive forces on single grains and bed liquefaction are the mechanisms of scour. (Lantz-PTT)
W91-10746

ORGANIC CARBON ACCUMULATION IN BAFFIN BAY AND PALEOENVIRONMENT IN HIGH NORTHERN LATITUDES DURING THE

PAST 20 M. Y.
Giessen Univ. (Germany, F.R.). Inst. fuer Geowissenschaften und Lithospharenforschung.

Geology GLGYBA, Vol. 19, No. 4, p 356-359, April 1991. 3 fig, 29 ref. Deutsche Forschungsge-meinschaft Grant No. STE 412/1.

Descriptors: \*Climatic changes, \*Cores, \*Greenland, \*Organic carbon, \*Paleoclimatology, \*Sediment transport, \*Sedimentation rates, Accumulation, Glacial drift, Glaciation, Pollen, Snowmelt, Spores, Tundra, Vegetation.

The results of the investigation of organic carbon deposition in Baffin Bay, Greenland, provide important information about paleoenvironmental evolution in high northern latitudes during Cenozoic time. During Miocene to Quaternary time, organic carbon enrichment of up to 3% in sediments sam-pled at Ocean Drilling Program Site 645 was conpled at Ocean Drilling Program Site 645 was controlled mainly by an increased supply of terrige-nous organic matter. Two distinct maxima were identified: (1) a middle Miocene maximum, possibly reflecting a dense vegetation cover and fluvial sediment supply from adjacent islands, which decreased during late Miocene and early Pilocene time because of expansion of tundra vegetation due to global climatic deterioration; and (2) a late Pilocene-Pleistocene maximum probably caused by glacial erosion and meltwater outwash. Significant amounts of marine organic carbon were deposited in Baffin Bay during middle Miocene time, suggesting higher surface water productivity triggered by the inflow of cold and nutrient-rich Arctic water masses. The decrease in average surface water productivity to values similar to those of modern Baffin Bay occurred during the late Miomater productivity to values similar to those of modern Baffin Bay occurred during the late Mio-cene and were probably caused by development of a seasonal sea-ice cover, reaching maximum expan-sion during the past 3.4 m.y. (Author's abstract) W91-10791

FAST ALGORITHM FOR AUTOMATICALLY COMPUTING STRAHLER STREAM ORDER, Geological Survey, Reston, VA. Water Resources

Water Resources Bulletin WARBAQ, Vol. 26, No. 6, p 977-981, December 1990. 2 fig, 5 ref.

Descriptors: \*Algorithms, \*Computer programs, \*Geographic information systems, \*Geomorpho-

logy, \*Stream classification, \*Stream order, \*Terrain analysis, Computation time, Digital map data, Headwaters, Raritan River, Strahler stream order,

In the Strahler system for ordering a stream network, all headwater streams (i. e., streams shown on the map, but into which no other streams flow) are assigned an order of 1. The order increases as one proceeds downstream. Since numbering begins in the headwaters, the Strahler stream order is dependent on the resolution of the stream network depicted on the source map. In a Geographic Information System (GIS), a stream network can be represented as a series of connected arcs. Each arc is an ordered set of x,y coordinates that identiarc is an ordered set of x,y coordinates that identifies the location or tracing of a stream segment. Stream locations may be derived from a digital elevation model (DEM) using an algorithm. An efficient algorithm has been developed to determine Strahler stream order for segments of stream networks represented in a GIS for the Raritan networks represented in a GIS for the Raritan River. Where digital elevation data of adequate resolution are available, this technique offers the prospect of deriving the stream network in much greater detail and consistency than is generally shown on existing maps. The execution time for the algorithm was shown to vary nearly linearly with the number of stream segments in the network making it practical to use for analysis of large stream networks. (Korn-PTT) large stream networks. (Korn-PTT) W91-10818

SEASONAL INFLUENCES ON THE SEDI-MENT TRANSPORT CHARACTERISTICS OF THE SACRAMENTO RIVER, CALIFORNIA.

HE SACRAMENTO RIVER, CALIFORNIA. Bradford Univ. (England). Dept. of Civil Engineering and Structural Engineering. P. Goodwin, and R. A. Denton. Proceedings of the Institution of Civil Engineers PCIEAT, Vol. 91, No. Pt 2, p 163-172, March 1991. 4 fig, 13 ref.

Descriptors: \*California, \*Mathematical models, \*Model studies, \*Sacramento River, \*Seasonal variation, \*Sediment transport, \*Suspended sediments, Energy gradient, Hydrodynamics, Sediment analysis, Streamflow.

Field measurements of suspended sediment transport and streamflow collected by the Unites States Geological Survey on the Sacramento River from 1953 to 1976 were studied. Analysis of data show that the quantity of sediment transported by a given discharge can vary by nearly two orders of magnitude and that the first major flows following magnitude and that the first major flows following the dry season tend to transport more sediment than comparable discharges at other times in the year. Simple statistical tests were used to show that the peaks in suspended sediment load tend to lead peaks in streamflow at this site. The ramifications of these observations in assigning suitable boundary conditions in mathematical models were analyzed. These simple observations at a specific site show that substantial inaccuracies can be introduced at the boundaries of mathematical models. show that substantial inaccuracies can be introduced at the boundaries of mathematical models predicting sediment transport, particularly for long-term simulations. These errors will lead to inaccurate sediment predictions, and may initiate artificial bed transients and affect the hydrodynamic field. Detailed information with respect to energy slope, resistance characteristics, bed armoring, sediment size and availability should also be used, wherever possible, to establish a realistic boundary condition. (Medina-PTT) W91-10847

CHEMICAL COMPOSITION OF THE INTER-STITIAL WATER IN BOTTOM SEDIMENTS OF TYRRHENIAN SEA (WESTERN MEDITER-RANEAN): DIAGENETIC PROCESSES.

RANGEAN; BURGENETH PROCESSES: Alexandria Univ. (Egypt). Inst. of Graduate Studies and Research. S. M. Nasr, and Y. N. Gorsky. Scientia Marina, Vol. 54, No. 3, p 249-255, September 1990. 5 fig, 40 ref.

Descriptors: \*Bottom sediments, \*Diagenesis, \*Interstitial water, \*Marine sediments, \*Mediterranean Sea, \*Sediment chemistry, \*Sedimentation, Al-

# Group 2J-Erosion and Sedimentation

kalinity, Calcium, Chemical composition, Chlorides, Core sampling, Magnesium, Organic matter, Salinity, Sulfates, Tyrrhenian Sea.

Seven gravity core samples were collected from the Tyrrhenian Sea in order to study the type of interstitial water as well as the diagenetic processes governing sedimentation in the western Mediterra-nean during the Holocene. No drastic changes in nean during the Folocene. No drastic changes in the chemical composition of interstitial water oc-curred in the carbonate sediments of the Tyrrhen-ian Sea which preserved their original type, i.e., oceanic type (MgSO4). Aerobic conditions prevail-ing during the Holocene may explain this phe-nomenon. Normal values of salinity (averaging 38) were found, except in the southern part of the sea where a value of 43.88 was recorded. The chemical composition of interstitial water of this region has been influenced, to some extent, by volcanic has been influenced, to some extent, by volcanic activity and by infiltration of brines from the underlying Messinian evaporites. Alkalinity was low for most of the investigated core samples. This can be attributed to the weak effect of biogenic processes such as oxidation of organic matter and sulfate reduction. The slight tendency for decreasing alkalinity, Ca, Mg, Ca/Mg, Ca/Cl and Mg/Cl of interstitial water with depth in sediments for some core samples may reflect limited development of ion-exchange and adsorption processes between sediments and interstitial water. (Author's abstract) W91-10880

ENGINEERING GEOLOGY OF NEARSHORE AREAS OFF RICHARDS ISLAND, N.W.T.: A COMPARISON OF STABLE AND ACTIVELY ERODING COASILINES.

Geological Survey of Canada, Ottawa (Ontario). P. J. Kurfurst, and S. R. Dallimore. Canadian Geotechnical Journal CGJOAH, Vol. 28, No. 2, p 179-188, April 1991. 10 fig, 2 tab, 16

Descriptors: \*Canada, \*Coastal environment, Descriptors: Canada, Coasaa curtonnicii, Coasaa Cartonnicii, Canada Cartonnicii, Coasaa Cartonnicii, Cartonniciii, Cartonnicii, Cartonnicii, Cartonniciii, Cartonnicii, Cartonnicii,

Major oil and gas discoveries in the shallow waters near Richards Island, N.W.T., Canada, have crenear Kichards Island, N. W. I., Canada, have cra-ated an urgent need for regional and site-specific knowledge of geological, geotechnical, and geo-thermal conditions of the coastal zone of the south-ern part of the Beaufort Sea. These areas can be expected to show considerable variability in litholexpected to snow considerable variability in intology, strengths, and geothermal setting both in a temporal and a spatial sense. Drilling and laboratory studies carried out along onshore-offshore transects at a stable coastal site and an actively eroding coastal site have identified six major stratigraphic units of Holocene and pre-Holocene (Wisconsinan age). The main factors controlling the geotechnical properties of these sediments and their distribution are the occurrence of shallow permafrost beneath areas seasonally covered by landfast sea ice, rapid degradation of permafrost in areas farther offshore, ice content of thawing pre-Holocene sediments, and variability in coastal processes. The design of shallow and deep foundations in this environment must consider all aspects of the thermal and geological regimes at any site located in the nearshore zone. Site surveys should include an overview of zone. Site surveys should include an overview of regional coastal geology, including coastal processes and permafrost regime. Potential problems that may influence foundation design include the widespread occurrence of shallow permafrost; high rates of coastal erosion or deposition, deformation, or disruption of local stratigraphy owing to glacio-tectonics; thaw settlement owing to degradation of permafrost, liquefaction, and high pore-water salin-ities. (Fish-PTT) W91-10944

SEPTEMBER 5, 1987, LANDSLIDE ON THE LA GRANDE RIVER, JAMES BAY, QUEBEC, CANADA.

Sherbrooke Univ. (Quebec). G. Lefebvre, P. Rosenberg, J. Paquette, and J. G.

Canadian Geotechnical Journal CGJOAH, Vol. 28, No. 2, p 263-275, April 1991. 12 fig, 2 tab, 6 ref. Descriptors: \*Bank erosion, \*Canada, \*Erosion, \*Landslides, \*Slope stability, \*Stream banks, Avalanches, Groundwater movement, Quebec, Shear stress, Slopes, Soil stability, Subsurface drainage.

The September 5, 1987, a landslide at kilometer 82.5 on La Grande River, James Bay, Quebec, Canada, affected a slope about 60 m high inclined at about 35 degrees. The site had been identified as presenting high risks of a major landslide and had been under observation for several years. The conditions existing before the landslide are relatively well documented from a deep boring put down in 1975 at the slide location and from prior observa-tions and photographs of the river bank erosion. The overburden deposit, sand at the ground sur-The overotiruen deposit, sand at the ground sufface changing to a silly clay at depth, was normally consolidated but affected by a strong underdrainage. Stability analyses confirm the strong underdrainage deduced from the 1975 piezometric reading. The silde retrogressed 290 m from the river on a surface inclined at 6 degrees. The retrogression devalored in the clawse sill have the gression developed in the clayey silt layer that forms a weaker transition between the granular material above and the silty clay below. The location of the retrogression surface appears related to the undrained shear strength profile; the actual location of the retrogression surface is above a jump of about 50 kPa in the undrained shear strength profile. Of all the factors behind this localized increase in shear strength, the most important appears to be a rapid increase in effective stress owing to an important underdrainage. Parametric effective stress analyses of the first slide indicate that to stand with the preside geometry, the slope needed an underdrainage equivalent to a ratio of about 0.1, which is in good agreement with the groundwater regime inferred from the 1975 data and observed at other sites in the area. This site confirms the important role of the groundwater regime in the slope-stability conditions of high riverbanks. (Fish-PTT) W91-10946

RECENT SEDIMENTATION IN LAKE MICHI-GAN.

Wisconsin Univ.-Milwaukee. Dept. of Civil Engi-

wisconsin Univ.-Milwaukee. Dept. of Civil Engineering.
M. H. Hermanson, and E. R. Christensen.
Journal of Great Lakes Research JGLRDE, Vol.
17, No. 1, p 33-50, 1991. 13 fig. 3 tab, 33 ref. U.S.
Environmental Protection Agency assistance
agreement R810419; U.S. National Science Foundation Grant No. CES-8701184.

Descriptors: \*Lake Michigan, \*Lake basins, \*Lake sediments, \*Limnology, \*Radioactive dating, \*Sediment distribution, \*Sedimentation rates, Lead radioisotopes, Mathematical models, Mixing, Sedient transport, Storm surges, Water circ

Measurement of sedimentation variables in lakes has made it possible to identify the processes gov-erning sediment movement and accumulations. Sediment cores from 21 locations in Lake Michigan were evaluated to identify sedimentation pat-terns including accumulation rates, surface layer mixing, focusing, and processes responsible for dis-continuous 210-Pb profiles. These patterns were identified based on two different sediment dating identified based on two different sediment dating models. Accumulation ratter vary consistently with basin topography in the north and central areas of the lake, while rates in the southern basin vary widely between sites. Mixing is apparent in all north basin sites but is seldom observed in the south basin and not in the central lake. Storm surges have influenced sediment accumulation, particularly in the south basin where sites are identified that have lost and gained sediment resulting from a storm. In particular, evidence was found of the 1888, 1905, and, most recently, the 1975 storms. Markers for these storms were not 1975 storms. Markers for these storms were not previously reported for Lake Michigan. Storm-related slumps and sand layer discontinuities were also identified. An extended period of dry and hot weather during 1913-1952 may have caused periodic lower sedimentation rates in the north basin, but not in the south where sediment redistribution but storms has obliterated records. Sediment focus. by storms has obliterated records. Sediment focusing is a minor process in the north basin, while in the south, the areas of highest sediment accumula-tion rates are also sites of highest measured focus-

ing, indicating that redistribution is a major variable in south basin sedimentation processes. (Author's abstract)

ACOUSTIC PARAMETRIC ARRAY FOR MEASURING THE THICKNESS AND STRATIGRAPHY OF CONTAMINATED SEDI-

MENTS.
Memorial Univ. of Newfoundland, St. John's.
Centre for Cold Ocean Resources Engineering.
J. Y. Guigne, N. Rukavina, P. H. Hunt, and J. S.

Journal of Great Lakes Research JGLRDE, Vol. 17, No. 1, p 120-131, 1991. 9 fig, 19 ref.

Descriptors: \*Acoustics, \*Instrumentation, \*Lake Ontario, \*Lake sediments, \*Measuring instruments, \*Sediment contamination, \*Stratigraphy, Hamilton Harbour, Mapping, Sedimentation, Sediments, Sur-

Acoustic mapping and monitoring of thin contami-nated sediments in inland waters requires an optimized acoustic source. An experiment conducted in Hamilton Harbour, Lake Ontario, demonstrated that high resolution recording of sediment layering is possible when a parametric acoustic source is used. Good correlation was obtained with the straigraphy of cores from the test site, and parametric records revealed a 4-cm ooze layer at the surface that could not be resolved using a conventional acoustic source. The encouraging performance of the parametric source for measuring thickness of sediments, which is typically not amenable to secuments, which is typically not amenable to acoustic measurement, suggests that an acoustic parametric array might be a useful tool for moni-toring sedimentation processes or for high-resolu-tion surveys of modern sediment thickness and volume. (Author's abstract) W91-10981

OPEN CHANNEL VELOCITY PROFILES OVER A ZONE OF RAPID INFILTRATION. Aberdeen Univ. (Scotland). Dept. of Engineering. For primary bibliographic entry see Field 8B. W91-10984

CHANGES WITH TIME OF THE TRANSPORT

RATE OF SEDIMENT MIXTURES.
Aberdeen Univ. (Scotland). Dept. of Engineering. For primary bibliographic entry see Field 7B. W91-10988

DISTANCE OF MOVEMENT OF COARSE PARTICLES IN GRAVEL BED STREAMS. British Columbia Univ., Vancouver. Dept. of Ge-

ography.
M. A. Hassan, M. Church, and A. P. Schick.
Water Resources Research WRERAQ, Vol. 27,
No. 4, p 503-511, April 1991. 4 fig, 3 tab, 20 ref.

Descriptors: \*Bed load, \*Sediment transport, \*Stream sediments, \*Streambeds, Bed-load discharge, Comparison studies, Data interpretation, Israel, Judean Desert, Mathematical models, Model studies, Negev Desert, Statistical analysis.

The fundamental phenomenon occurring during transport of clastic particles by fluid flow is the displacement of individual grains. Distributions of distance of bedload particle movement were examined in two gravel-bed streams (Negev and Juden Deserts, Israel) using 450 magnetically tagged cobbles and pebbles at one site and 245 such particles bles and pebbles at one site and 245 such particles at the other. The compound Poisson model of Einstein-Hubbell-Sayre and a simple gamma function model were compared with observed distributions of moved particles and of all particles. Both models fit the data reasonably well for small mean displacements, but notable misfits occurred in an event with large mean displacement. When mean particle travel distance approaches the scale of bar event with large mean displacement. When mean particle travel distance approaches the scale of bar spacing, trapping in the bars interrupts particle progress and the dispersion process. The data remain very noisy, so definitive discrimination of suitable models will require trials with more than 1000 particles. (Author's abstract) W91-11231

MORPHOLOGY AND QUANTITATIVE ANALYSIS OF FLUVIAL EROSION SYSTEMS IN THE HYDROLOGICAL NETWORK OF THE BASQUE COUNTRY AUTONOMOUS

Ambiotek, Investigacion Cientifica y Tecnica del Medio Ambiente Mendi Alde, No. 13 IOB, Or-

Metido Ambiento Metido Ante, 190. 15 10B, Ortuella (Biztraia), Spain.

L. Docampo, E. Rico, M. A. Sevillano, B. G. de
Bikuna, and A. Rallo.

Journal of Environmental Management
JEVMAW, Vol. 32, No. 3, p 251-266, April 1991.

4 fig, 8 tab, 19 ref.

Descriptors: \*Erosion, \*Geomorphology, \*River systems, \*Spain, \*Stream erosion, Climates, Flood forecasting, Lithology, Orography, River beds, Tectonics, Topography.

Using the Strahler-Schumm hierarchical classifica-tion on topographic maps with a 1:50,000 scale, a morphometric study was made of the whole hy-drographic network of the Basque Country (north-ern Spain). By applying Horton's bifurcation radius (law of number of river beds), the law of allome-tric growth, the longitudinal profile and the hypso-metric curve, it was determined that geomorpholo-gical heterogeneity due to orographic, climatic, lithological and tectonic factors is 95.77% in the river basins of Vizcaya, 73.96% in those of Gui-puzcoa, and 14.03% in those of Alava, with re-spect to isometrics. This is due to two crosion strategies in the river networks: vertical in Guipuz-Using the Strahler-Schumm hierarchical classificaspect to isometrics. This is due to two erosion strategies in the river networks: vertical in Guipuzcoa and horizontal in Alava. In Vizcaya both types are present. These strategies are related to the dynamics of the rivers' ecosystems. Where horizontal erosion predominates the river shows more conspicuous autotrophy in its middle reaches and generally has a higher primary production. Where vertical erosion prevails, heterotrophy predominates with allochthonous energy prevailing from the banks. These rivers generally have greater forest cover on the banks, and heterotrophy dominates from first-order water courses to fourth-order ones. These data are useful in calculating the nates from Inst-order water courses to fourth-order ones. These data are useful in calculating the potential risk of floods, establishing a comparison with the real risk and modeling ecological flow rates. (Geiger-PTT) W91-11265

USE OF 137CS AS A TRACER IN AN EROSION STUDY IN SOUTH LIMBURG (THE NETHER-LANDS) AND THE INFLUENCE OF CHERNO-BYL FALLOUT.

Utrecht Rijksuniversiteit (Netherlands). Inst. of Geographical Research.

For primary bibliographic entry see Field 7B. W91-11351

FLOOD-HAZARD ZONATION IN ARID

Geological Survey, Tucson, AZ. For primary bibliographic entry see Field 6F. W91-11390

GRAPHICAL METHOD FOR DETERMINING THE COEFFICIENT OF CONSOLIDATION CV FROM A FLOW-PUMP PERMEABILITY TEST. Geological Survey, Denver, CO. For primary bibliographic entry see Field 7C. W91-11393

SNOW AND ICE PERTURBATION DURING HISTORICAL VOLCANIC ERUPTIONS AND THE FORMATION OF LAHARS AND FLOODS.

Cascades Volcano Observatory, Vancouver, WA. For primary bibliographic entry see Field 2C. W91-11394

DENDROGEOMORPHIC APPROACH TO MEASUREMENT OF SEDIMENTATION IN A FORESTED WETLAND, BLACK SWAMP, AR-KANSAS

Geological Survey, Reston, VA.

For primary bibliographic entry see Field 2H. W91-11397

EFFECTS OF SUSPENDED SEDIMENTS ON AQUATIC ECOSYSTEMS.

AQUATIC ECUSYSTEMS.
British Columbia Ministry of Environment, Victoria. Environmental Protection Div.
For primary bibliographic entry see Field 5C.
W91-11426

ROUGHNESS COEFFICIENTS OF WATER-COURSE REVETTED WITH HALF-CIRCULAR CONCRETE PIPES, RESULTS OF FIELD MEASUREMENTS IN WATERCOURSE S 333

MEASUREMENTS IN WATERCOURSE S 333 AT MAARKEDAL.
Ministry of the Flemish Community, Administration of Environmental Planning and the Environment, Working Group for Rural Water Management in the Flemish Region, Merelbeke, Belgium. For primary bibliographic entry see Field 8B.
W91-11431

HEAVY METAL DISTRIBUTION IN THE GODVARI RIVER BASIN.

Mineral Exploration Corp., Nagpur (India). For primary bibliographic entry see Field 5B. W91-11445

REACTIVE CONTINUUM REPRESENTATION OF ORGANIC MATTER DIAGENESIS.

Dalhousie Univ., Halifax (Nova Scotia). Dept. of

Daniouse Univ., Hainax (INVA Scota). Dept. of Oceanography.

B. P. Boudreau, and B. R. Ruddick.
American Journal of Science AJSCAP, Vol. 291, No. 5, p 507-538, May 1991. 67 ref, append. Natural Sciences and Engineering Research Council (Canada) Grants UR0043963 and OGP0008482.

Descriptors: \*Decomposition, \*Diagenesis, \*Organic matter, \*Sedimentology, Distribution, Energy, Kinetics, Mathematical studies, Model studies, Profiles, Sediments, Statistical analysis, Statistical models, Temperature.

A theory is presented for the decay of sedimentary organic matter made of a spectrum (a continuous distribution of an infinite number) of reactive types which can be characterized by a variable function of the decay constant, k. A fundamental property of the continuum theory is that it can generate an apparent order of reaction for the decay of the total mixture greater than one. The apparent order is related to the predominance of the more refractory components of the continuum relative to the more reactive. The continuum model, based on the Gamma distribution, requires half as many parameters as the traditional multi-exponential model. The continuum model was applied to nine organic matter profiles taken in non-mixed sediments or below the mixed layer in bioturbated sediments or below the mixed layer layer and layer A theory is presented for the decay of sedimentary dramatically more involved than those of the G-model. For those who insist on an analytical solu-tion, the continuum model would appear to be at a practical, but not conceptual, disadvantage in this case unless the mixed zone can be assumed to extend to infinity. While the continuum theory may initially suggest a complicated treatment for the energetics of the decay process, it was shown that for the temperature range normal to sedimen-tary environments, the Arrhenius plot can still be used to derive an effective activation energy for used to derive an effective activation energy for the total organic mass. (Doria-PTT) W91-11448

MAGNETITE FORMATION DURING MICRO-BIAL DISSIMILATORY IRON REDUCTION. Geological Survey, Reston, VA. Water Resources

D. R. Lovley.

IN: Iron Biominerals. Plenum Press, New York.
1990. p 151-1166, 2 fig, 53 ref.

Descriptors: \*Magnetite, \*Microbial degradation, \*Biodegradation, \*Iron, \*Geomagnetic studies, \*Geochemistry, Iron bacteria, Oxidation, Waste

### Chemical Processes—Group 2K

There is geochemical evidence that magnetite is formed during the reduction of Fe(III) coupled to organic matter oxidation in anaerobic environments. Furthermore, it is known that the oxidation of organic matter coupled to Fe(III) reduction is primarily catalyzed by the direct enzymatic activity of dissimilatory Fe(III)-reducing bacteria. Studies with microbial cultures have supported the conclusion that magnetite is an end product of microbial Fe(III) reduction. The production of magnetite appears to be a nonenzymatic reaction in which the Fe(III) produced during Fe(III) reduction reacts abottically with Fe(III). The extent of magnetite production is controlled by other nonenzymatic reactions, such as siderite formation, that compete for Fe(II). Dissimilatory microbial Fe(III)-reduction appears to have generated favorable conditions for magnetite formation in such diverse sedimentary environments as the ancient iron formations, hydrocarbon seeps, rice paddy formed during the reduction of Fe(III) coupled to diverse sedimentary environments as the authention formations, hydrocarbon seeps, rice paddy soils, and freshwater and marine sediments. However, how much of the remnant magnetization of various sediments is the result of authigenic production of magnetite during dissimilatory Fe(III) reduction and how much can be attributed to soil-derived magnetite, or the magnetite of magnetotactic bacteria is an important unresolved question. (Lantz-PTT) W91-11544

#### 2K. Chemical Processes

IODINE CHEMISTRY IN THE WATER COLUMN OF THE CHESAPEAKE BAY: EVIDENCE FOR ORGANIC IODINE FORMS. Delaware Univ., Lewes. Coll. of Marine Studies. For primary bibliographic entry see Field 2L. W91-10496

WATER EXCHANGE AND TRANSPORT OF MATTER IN THE SETO INLAND SEA. Ehime Univ., Matsuyama (Japan). Dept. of Ocean Engineering.
For primary bibliographic entry see Field 2L.
W91-10527

INFLUENCE OF POLYELECTROLYTE CHARACTERISTICS ON SLUDGE CONDITIONING (LAB EVALUATIONS). Istituto di Ricerca sulle Acque, Bari (Italy). For primary bibliographic entry see Field 5D. W91-10701

DETERMINATION OF SUBNANOMOLAR LEVELS OF IRON(II) AND TOTAL DIS-SOLVED IRON IN SEAWATER BY FLOW IN-JECTION ANALYSIS WITH CHEMILUMINES-CENCE DETECTION.

CENCE DETECTION.
Moss Landing Marine Labs., CA.
V. A. Elrod, K. S. Johnson, and K. H. Coale.
Analytical Chemistry ANCHAM, Vol. 63, No. 9,
p 893-898, May 1991. 8 fig. 3 tab, 36 ref. ONR
Grant No. N00014-89-J-1070 and NSF Grant No.

Descriptors: \*Analytical methods, \*Analytical techniques, \*Chemical analysis, \*Iron, \*Measuring instruments, \*Seawater, \*Water analysis, Cation exchange, Data acquisition, Detection limits, Luminescence, Sample preparation, Standard deviction

A highly sensitive technique has been developed for the rapid determination of Fe(II) and total dissolved from in seawater. The technique employs flow injection analysis and chemiluminescence denow injection analysis and chemiuminescence de-tection (FIA-CL). The light is emitted by the reaction of brilliant sulfoflavin with hydrogen per-oxide and Fe(II) in a neutral medium. A cation-exchange column is used to preconcentrate the exchange column is used to preconcentrate the irron from seawater. The detection limit was 0.45 nmol/L when 4.4 mL of sample was passed through the column. Lower detection limits are attainable with larger sample volumes. The relative standard deviation is 2-5% for concentrations greater than 2.5 nmol/L. A typical analysis can be performed in 5 min. The technique was determined to be accurate based on the analysis of the North

### **Group 2K—Chemical Processes**

Atlantic Surface Seawater (NASS) and Coastal Atlantic Surface Seawater (CASS) trace metal standard seawater solutions. Shipboard analyses provided oceanographically consistent profiles for total iron and also revealed some of the first profiles for Fe(II) in hydrothermal plume samples. A typical profile of 12 samples, together with blanks and standards, can be analyzed in triplicate in 4.5 hours. (Author's abstract) W91-10773

FATE OF SILICATE MINERALS IN A PEAT

Texas Univ. at Austin. Dept. of Geological Sci-For primary bibliographic entry see Field 2H. W91-10789

CHARACTERIZATION OF RADIOACTIVITY IN HOT SPRINGS NATIONAL PARK, ARKAN-

Arkansas Univ. for Medical Sciences, Little Rock.

Coll. of Pharmacy.
C. E. Epperson, and N. R. Rhodes.
Proceedings of the Arkansas Academy of Science
AKASAO, Vol. 44, p 125-127, 1990. 1 fig, 6 tab, 5

Descriptors: \*Arkansas, \*Hot springs, \*National parks, \*Radioactive springs, \*Radon, \*Thermal springs, Gamma radiation, Public health, Radioactivity techniques, Radium

The thermal springs of Hot Springs National Park in Arkansas are radioactive and have been a natu-ral resource of international renown which have rai resource of international renown which have attracted many tourists for many years. A study was made to learn the types and measure the levels of radioactive emissions found within the park boundaries and to determine if the emissions pose a obundants and to determine in the emissions pose a significant health hazard to the public or to park workers. The radioactivity of the hot spring waters is due mostly to dissolved radon and radon daugh-ters with a small contribution from radium. Radon concentrations were measured using passive alpha track monitors and, in some cases, activated chartrack monitors and, in some cases, activated char-coal canisters. A pressurized ion chamber and en-vironmental thermoluminescent dosimeters were used to make differential and integral exposure measurements of radon daughters. The largest ex-posure rates were observed from springs located at higher elevations. Rates decreased considerably at lower levels. This is probably due to the migration lower levels. This is probably due to the migration of radon gas back up the gravity collection system to higher elevations. A highly localized area of relatively intense gamma radiation was found at an abandoned spring site on the upper slopes. Radon levels in dwellings and other park buildings are below any current action level. Bathhouse basements have some potential for becoming hazardous but this can probably be remedied with ventilation and sealing of cracks. The highest external exposures exist over and immediately adjacent to therand sealing of cracks. The highest external expo-sures exist over and immediately adjacent to ther-mal spring openings. Essentially all spa areas were well within acceptable radiation exposure limits. Radon and daughters comprise essentially all of the radioactivity present in the park. Dried-up springs no longer emit gamma rays. The presence of water is evidently necessary for gamma emis-sions to exist. (Medina-PTT) W91-10846

CHEMICAL COMPOSITION OF THE INTER-STITIAL WATER IN BOTTOM SEDIMENTS OF TYRRHENIAN SEA (WESTERN MEDITER-RANEAN): DIAGENETIC PROCESSES.
Alexandria Univ. (Egypt). Inst. of Graduate Stud-

ies and Research.
For primary bibliographic entry see Field 2J.
W91-10880

ION CONCENTRATIONS IN INTERSTITIAL WATER AS INDICATORS FOR PHOSPHORUS RELEASE PROCESSES AND REACTIONS.

RELEASE PROCESSES AND REACTIONS. Limnologisch Inst., Nieuwersluis (Netherlands). Vijverhof Lab. P. Boers, and F. De Bles. Water Research WATRAG, Vol. 25, No. 5, p 591-598, May 1991. 4 fig, 7 tab, 21 ref.

Descriptors: \*Diagenesis, \*Eutrophic lakes, \*Interstitial water, \*Ions, \*Lake sediments, \*Limnology, \*Mineralization, \*Phosphates, \*Phosphorus, Ammonia, Ammonium nitrogen, Dissolved organic carbon, Hydrogen ion concentration, Iron, Lake Loosdrecht, Nitrogen, The Netherlands.

Sediment composition and interstitial water concentrations of soluble reactive phosphorus (SRP), dissolved iron, ammonia nitrogen and dissolved organic carbon and pH were monitored at 5 sampling stations in the shallow Lake Loosdrecht (Netherlands). The differences in concentrations between the sediments were much larger than the differences in overall sediment composition. The concentrations of SRP and ammonia were strongly correlated, and the ratio between them was close to that predicted from a mineralization model. Possibly, the high concentrations of refractory organic material in the sediments affect the availabil-ity of iron. The pore water was calculated to be frequently supersaturated with respect to vivianite. However, this did not seem to affect the phosphate concentrations in the pore water. (Author's ab-

RAPID PRECONCENTRATION METHOD FOR MULTIELEMENT ANALYSIS OF NATURAL FRESHWATERS.

Stockholm Univ. (Sweden). Dept. of Geology. For primary bibliographic entry see Field 7B. W91-10892

HYDROGEOCHEMICAL PROCESSES CONTROLLING SUBSURFACE TRANSPORT FROM AN UPPER SUBCATCHMENT OF WALKER BRANCH WATERSHED DURING STORM EVENTS. 1. HYDROLOGIC TRANSPORT PROCESSES.

Tennessee Univ., Knoxville. Dept. of Plant and

For primary bibliographic entry see Field 5B. W91-10907

VOLTAMMETRIC DETERMINATION OF THE COMPLEXATION PARAMETERS OF ZINC IN MARINE AND ESTUARINE WATERS.

Rhode Island Univ., Kingston. Graduate School of

Oceanography. F. L. L. Muller, and D. R. Kester. Marine Chemistry MRCHBD, Vol. 33, No. 1/2, p 71-90, April 1991. 7 fig, 4 tab, 21 ref. Office of Naval Research Contract N00014-81-C-0062.

Descriptors: \*Analytical methods, \*Estuarine environment, \*Marine environment, \*Metal complexes, \*Voltammetry, \*Water analysis, \*Zinc, Chemical properties, Chemical speciation, Continental slope, Heavy metals, Narragansett Bay, Phytoplankton.

Heavy metals, Narragansett Bay, Phytoplankton. For most phytoplankton, a close correlation has been found between trace metal speciation and biological response (including metal uptake, bioconcentration, bioavailability, and toxicity). Recent studies on the complexation of zinc in estuarine, neritic, and upper-ocean environments have pointed to the importance of organic substances-both molecular and colloidal-in the speciation of zinc. Anodic stripping voltammetry (ASV) at the rotating disk electrode was used to probe the zinc-organic ligands interactions in Narragansett Bay Water samples and in samples collected in the Slope Water region off the U.S. mid-Atlantic Bight. In Narragansett Bay Water, two distinct groups of complexing ligands were detected, which have conditional stability constants (log K) of 7.7 and 7.0 and represent solution and surface complexation respectively. In samples collected near the western edge of the Gulf Stream two classes of dissolved organic ligands could be distinguished, with average stability constants (log K1, log K2) of 9.3 and 7.6. Because of the complexity of the systems studied, the complexation properties of these ligands had to be measured over a range of of the systems studied, the complexation properties of these ligands had to be measured over a range of of these figands had to be measured over a range of pH values and/or a range of electrode rotation rates, to obtain correct and precise estimates of their stability constants. This type of approach gave a complex but coherent interpretation of all ASV data (i.e. variation of the ASV signal with

zinc concentration, pH and electrode rotation rate), and is to be particularly recommended to workers confronted with new or complex marine systems. (See also W91-10926) (Agostine-PTT) W91-10924

MEASUREMENT OF THE DIFFERENT FORMS OF ZINC IN NARRAGANSETT BAY WATER BASED ON THE RATE OF UPTAKE BY A CHELATING RESIN.

Rhode Island Univ., Kingston. Graduate School of

Oceanography. F. L. L. Muller, and D. R. Kester.

Marine Chemistry MRCHBD, Vol. 33, No. 1/2, p 171-186, April 1991. 5 fig, 2 tab, 16 ref.

Descriptors: \*Analytical methods, \*Chelating agents, \*Metal complexes, \*Narragansett Bay, \*Particulate matter, \*Water analysis, \*Zinc, Adsorption kinetics, Chemical properties, Heavy metals, Ion exchange, Phytoplankton, Resins.

Naturally occurring organic ligands in seawater may keep the free metal ion concentration nearly constant, in the range required for phytoplankton constant, in the range required for phytoplankton growth. A chelating ion-exchange procedure based on total exchange of the free metal was used to establish the rate laws describing the release of zinc from the particulate and dissolved organic forms naturally occurring in Narragansett Bay water. Batch treatment with Chelex-100 ion exchange resin was used to quantify the physico-chemical forms of zinc in Narragansett Bay water samples collected on seven dates between November 1982 and January 1986. Labile complexes of samples collected on seven dates between November 1982 and January 1986. Labile complexes of zinc in solution were rapidly taken up (100% uptake after 0.5 h); another two kinetically distinguishable components of the zinc pool were identified as 'moderately labile' organic and 'slowly labile' particulate forms, respectively. The first component followed pseudo-first-order kinetics of dissociation, whereas the particulate component gave a removal plot that could best be described as zero order. Although the distribution of zinc between sampling dates the rate constant charactertween sampling dates, the rate constant character-izing the release of zinc from each component showed little variation with season and tidal phase. One sample differed from the above analysis in that One sample different from the above analysis in that the removal of particulate zinc was found to conform to a surface binding site kinetic analysis, from which the first-order desorption rate constant was obtained. (See also W91-10924) (Agostine-PTT) W91-10926

ALGICIDAL AND CHEMICAL EFFECT OF U.V.-RADIATION OF WATER CONTAINING HUMIC SUBSTANCES, Norsk Inst. for Vannforskning, Oslo.

For primary bibliographic entry see Field 5F. W91-10941

GEOCHEMICAL EVOLUTION IN THE CAMBRIAN-ORDOVICIAN SANDSTONE AQUIFER, EASTERN WISCONSIN: 1. MAJOR ION AND RADIONUCLIDE DISTRIBUTION. Wisconsin Univ.-Madison. Dept. of Geology and

Geophysics.

T. R. Weaver, and J. M. Bahr. Ground Water GRWAAP, Vol. 29, No. 3, p 350-356, May/June 1991. 5 fig, 3 tab, 22 ref.

Descriptors: \*Geochemistry, \*Groundwater chemistry, \*Radioisotopes, \*Sand aquifers, \*Solute transport, \*Uranium, \*Wisconsin, Cation exchange, Chlorides, Dissolved solids, Radium, Sulfates, Water quality standards.

Groundwater from wells in the Cambrian-Ordovician sandstone aquifer of eastern Wisconsin often contains elevated concentrations of dissolved solids, chloride, and sulfate, and locally approaches or exceeds the current drinking water standard for combined radium activity. Samples were collected combined radium activity. Samples were collected from wells located along an approximate flow line in order to gain an improved understanding of the chemical evolution of groundwater in this system. It was found that the concentrations of chloride, sulfate, and sodium increase where the aquifer is

#### Chemical Processes—Group 2K

confined by the Maquoketa Shale, and the highest combined radium activity is also found in this area. Charge balance calculations and geochemical mod-eling indicate that dissolution of trace evaporite minerals and cation exchange are important mechanisms controlling major ion distribution. Isotopic equilibrium calculations and analysis of well cuttings from one well with alpha-sensitive film indicate that the dissolved radionuclide activities are consistent with a uranium source occurring in shaly intervals of the sandstone aquifer at maxi-mum local concentrations of 5 ppm. (Author's abstract) W91-10953

OPTICS OF LITTLE SODUS BAY. Upstate Freshwater Inst., Inc., Syracuse, NY. For primary bibliographic entry see Field 2H. W91-10980

HEAVY METAL TRANSPORT TO THE GREAT LAKES BY NATURAL GROUND-WATER DISCHARGE: AN INITIAL EVALUATION. For primary bibliographic entry see Field 5B. W91-11062

ATMOSPHERIC CARBON DIOXIDE AND THE GLOBAL CARBON CYCLE: THE KEY UNCERTAINTIES.
Oak Ridge National Lab., TN. Environmental Sci-

For primary bibliographic entry see Field 5B. W91-11068

INFLUENCE OF GREEN PLANTS ON THE WORLD CARBON BUDGET.

Institute of Tropical Forestry, Rio Piedras, PR. A. E. Lugo.

A. E. Lugo.

In: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemisphere Publishing Corporation, New York. 1990. p 79-86. 2 fig. 1 tab, 23 ref. US DOE Contract No. EV-78-S-036047.

Descriptors: \*Atmospheric chemistry, \*Carbon cycle, \*Mathematical models, \*Model studies, cycle, \*Mathematical models, \*Model studies, \*Vegetation effects, Anthropogenic effects, Carbon uptake, Ecosystems, Marine environment, Plant physiology, Primary productivity, River transport.

A model can be used to illustrate the role of plants in the global carbon budget, with emphasis given to questions about the interaction of terrestrial vegetation and the atmosphere. The model is used to formulate four hypotheses dealing with the role of plants in the global carbon budget. These are:

(1) perturbed plant-dominated ecosystem are carbon sinks; (2) all terrestrial ecosystems, if left undisturbed are natural sinks of atmospheric undisturbed, are natural sinks of atmospheric carbon; (3) human land use causes the biota to be a carbon, (5) Indian I and use causes the olivate ocea-carbon source; and (4) higher carbon dioxide con-centrations in the atmosphere create a carbon sink by stimulating plant gross primary productivity. Current understanding of the global carbon budget Current understanding of the global carbon budget indicates that the budget does not balance unless an unrecognized sink of carbon is operating in the ocean or in the vegetation. Known sources of atmospheric carbon (burning of fossis fuels, 5.3 PgC/yr) and clearing of tropical forests, 1.3 PgC/yr) and clearing of tropical forests, 1.3 PgC/yr) are 1.6 PgC/yr higher than known sinks (PgC/yr), and atmosphere, 3 PgC/yr). However, plant communities that appear to be 'undisturbed' and thus assumed to be neutral with respect to carbon exchange with the atmosphere, may sequester up to 100 gC/sq m/yr in soil, wood and through river transport. If this rate of uptake actually occurs over a significant land area, the carbon budget of the world may become more balanced. More research is needed in tropical ecosystems before a full understanding of the global carbon cycle can be achieved. (See also W91-11066) (Author's abstract)

KINETICS OF CHEMICAL WEATHERING IN B HORIZON SPODOSOL FRACTION.

Iowa Univ., Iowa City. Dept. of Civil and Envi-ronmental Engineering. For primary bibliographic entry see Field 5C. W91-1123

STREAM CHEMISTRY IN THE EASTERN UNITED STATES: 2. CURRENT SOURCES OF ACIDITY IN ACIDIC AND LOW ACID-NEUTRALIZING CAPACITY STREAMS. Utah Water Research Lab., Logan. For primary bibliographic entry see Field 5B. W91-11242

USE OF 2,2-DIMETHOXYPROPANE FOR THE DIRECT GAS CHROMATOGRAPHIC-MASS SPECTROMETRIC DETERMINATION OF SOME ORGANIC COMPOUNDS IN WATER. Consiglio Nazionale delle Ricerche, Padua (Italy). Servizio di Sicurezza del Lavoro e Protezio

For primary bibliographic entry see Field 5A. W91-11245

DETERMINATION OF TRACE LEVELS OF SULPHATE IN WATER USING FLOW-INJECTION AND IN-LINE PRECONCENTRATION. Tecator A.B., Hoganas (Sweden). M. Karlsson, J. A. Persson, and J. Moeller. Analytica Chimica Acta ACACAM, Vol. 244, No.

1, p 109-113, March 1991. 2 fig, 1 tab, 14 ref.

Descriptors: \*Ion exchange, \*Mass spectrometry, \*Preconcentration, \*Sulfates, \*Trace levels, \*Water analysis, Analytical methods, Anions, Cations, Pollutant identification, Sample preparation,

Sulfate is preconcentrated on a strong anion-exchange resin and determined using the effect of sulfate ions on the complexation of methylthymol blue and barium. A computer-controlled flow-injection analyzer is used to automate the whole procedure. The resin has two functions: it preconcentrates sulfate and also separates sulfate from divalent cations that may interfere in the determination step. The system can handle 30 samples per hr and has a working range from 25 to 100 micrograms/L of sulfate. Lower detection limits can be obtained by changing the preconcentration condiobtained by changing the preconcentration condi-tions. The effect of both anionic and cationic interferents was studied. In the direct measurement of sulfate without preconcentration, the main interfe surface without preconcentration, the main interest-ence is from divalent cations competing with barium in binding to the methylthymol blue rea-gent. A cation exchanger placed in the sample line or in the manifold can minimize this interference. Cationic interferents can be totally removed using Cationic interferents can be totally removed using a preconcentration scheme and by adding a proper wash cycle using calcium. The effects of various amounts of chloride, nitrate, and phosphate anions were studied. The relative selectivities for HSO4(-), NO3(-), and Cl(-) to the AG 1-X8 resin are 85, 65, and 22, respectively, which means that higher concentrations of chloride than nitrate should be tolerated. For chloride, concentrations up to about 2000 mg/L had no effect on the sulfate sensitivity 2000 mg/L had no effect on the sulfate sensitivity whereas for nitrate only about 200 mg/L could be tolerated. The tolerance limit for phosphate is between 1 and 5 mg/L. This interference can be controlled to some extent by decreasing the pH in the samples prior to the preconcentrations. (Geiger-PTT) W91-11246

SELECTIVE CONCENTRATION OF LEAD(II) CHLORIDE COMPLEX WITH LIQUID ANION-EXCHANGE MEMBRANES.
Texas Tech Univ., Lubbock. Dept. of Chemistry and Biochemistry.
For primary bibliographic entry see Field 5D.
W91-11247

SEQUENTIAL SAMPLING OF PARTICLES, MAJOR IONS AND TOTAL TRACE METALS IN WET DEPOSITION.
University of East Anglia, Norwich (England). School of Environmental Sciences.
For primary bibliographic entry see Field 5B.

W91-11249

MAJOR IONS IN MARINE RAINWATER WITH ATTENTION TO SOURCES OF ALKA-LINE AND ACIDIC SPECIES. Paris-7 Univ. (France). Lab. de Physico-Chimie de l'Atmosphere. For primary bibliographic entry see Field 5B. W91-11250

MODELLING THE ATMOSPHERIC TRANS-PORT OF TRACE METALS INCLUDING THE ROLE OF PRECIPITATING CLOUDS. GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). For primary bibliographic entry see Field 5B. W91-11251

AEROSOL AND HYDROMETEOR CONCENTRATIONS AND THEIR CHEMICAL COMPOSITION DURING WINTER PRECIPITATION ALONG A MOUNTAIN SLOPE: III. SIZE-DIF-FERENTIATED IN-CLOUD SCAVENGING EF-FICTENCIES.

Edigenoessische Technische Hochschule, Zurich (Switzerland). Atmospheric Physics Lab. For primary bibliographic entry see Field 2B. W91-11253

CONTINUOUS FLOW THIN-LAYER HEADSPACE (TL.HS) ANALYSIS, I. CONDUCTOMETRIC DETERMINATION OF VOLATILE ORGANIC HALOGENS (VOX) IN TAP WATER.
Gdansk Technical Univ. (Poland). Inst. of Inorganic Chemistry, Technology and Corrosion.
For primary bibliographic entry see Field 5A.
W91-11256

FLOW-RATE VARIATED HPLC-/EC-DETER-MINATION OF PHENOLS. Karl-Marx-Univ., Leipzig (German D.R.). Dept. of Chemistry. bibliographic entry see Field 5A.

HYDROCHEMISTRY OF A GROUNDWATER-SEAWATER MIXING ZONE, NAURU ISLAND, CENTRAL PACIFIC OCEAN.

New South Wales Univ., Kensington (Australia). Centre for Groundwater Management and Hydro-

J. Jankowski, and G. Jacobson J. Jankowski, and G. Jacobson.

BMR Journal of Australian Geology & Geophysics BJAGDT, Vol. 12, No. 1, p 51-64, 1991. 17 fig,

Descriptors: \*Geohydrology, \*Groundwater chemistry, \*Hydrologic data, \*Islands, \*Karst hy-drology, \*Saline-freshwater interfaces, Brackish water, Dolomite, Marine geology, Mixing, Oceans, Saline water, Salinity, Seawater, Vadose water.

Nauru Island is a karstified dolomitic limestone island in the central Pacific Ocean. An investigation of the island's hydrogeology has recently been undertaken in order to assure water resources for land rehabilitation of a large surficial phosphate mine. The investigation proved a thin, discontinu-ous freshwater layer overlies a thick brackish water mixing zone. Groundwater samples were collected from wells and caves, and also obtained during drilling. In the mixing zone, groundwater salinity increases gradually downwards until seawater is encountered at about 70 m below sea bicarbonate-calcium-magnesium groundwaters evolve to seawater. Saturation indi-ces for particular carbonate minerals increase with ces for particular carbonate minerals increase with increased groundwater salinity. Supersaturation is achieved with dolomite at 300 mg/L total dissolved solids, with calcite at 5000 mg/L, and with aragonite at 6000 mg/L. As groundwaters in the mixing zone are saturated with dolomite there is potential for dolomitization, and this probably occurs at low proportions of admixed seawater. Open and closed system trends can be defined, based on the partial pressure of carbon dioxide.

# **Group 2K—Chemical Processes**

The open system, with lower partial pressure, comprises vadose waters, cave waters and the more saline mixing zone waters; in the latter, chemical evolution is controlled mainly by mixing with seawater. The closed system comprises the freshwater layer with low proportions of admixed seawater; its chemistry is controlled by ingassing of carbon dioxide and by dissolution and precipitation reactions. Theoretical calculations based on simple mixing between karst groundwaters and seawater are inadequate to describe actual chemi-cal processes, which change with the degree of mixing. (Author's abstract) W91-11297

MULTICOMPONENT KINETIC ANALYSIS OF IRON SPECIATION IN HUMIC LAKE TJEU-KEMEER: COMPARISON OF FULVIC ACID FROM THE DRAINAGE BASIN AND LAKE WATER SAMPLES.

CB Research International Corp., Sidney (British Columbia).

For primary bibliographic entry see Field 2H. W91-11339

STIMULATION OF THE REDUCTIVE DECH-LORINATION OF TETRACHLOROETHENE IN ANAEROBIC AQUIFER MICROCOSMS BY THE ADDITION OF TOLUENE. Robert S. Kerr Environmental Research Lab.,

For primary bibliographic entry see Field 5B. W91-11344

DYNAMICS OF PESTICIDES IN TROPICAL CONDITIONS, 1. KINETIC STUDIES OF VOLATILIZATION, HYDROLYSIS, AND PHOTOLYSIS OF DIELDRIN AND ALPHA AND BETA ENDOSULFAN.

University of the West Indies, Kingston (Jamaica). Dept. of Chemistry.

For primary bibliographic entry see Field 5B. W91-11375

GEOCHEMICAL EVOLUTION OF GROUND WATER IN SMITH CREEK VALLEY-A HYDROLOGICALLY CLOSED BASIN IN CENTRAL NEVADA, U.S.A.

Geological Survey, Carson City, NV.
J. M. Thomas, A. H. Welch, and A. M. Preissler.
Applied Geochemistry APPGEY, Vol. 4, p 493510, 1989. 16 fig. 5 tab, 52 ref.

Descriptors: \*Geochemistry, \*Groundwater chemistry, \*Groundwater quality, \*Smith Creek Valley, Aquifers, Bicarbonates, Calcite, Calcium, Cation exchange, Chemical precipitation, Chlorides, Dissolved solids, Evapotranspiration, Groundwater recharge, Infiltration, Mountain streams, Nevada, Playas, Sodium, Stream discharge, Weathering,

Smith Creek Valley is a hydrologically closed basin in which groundwater is recharged by sub-surface inflow from surrounding mountains and infiltration of streamflow into alluvial-fan deposits near the mountains. Groundwater is discharged by evapotranspiration from shallow groundwater areas in the central part of the basin. Dominant ions in the dilute recharge water are Na, Ca and HCO3. Dissolved solids concentration increases during flow through the basin-fill sediments, with Na becoming increasingly dominant. In the dis-charge area, a bare-soil playa surrounded by phreatophytic vegetation, groundwater salinity, domi-nated by Na and Cl, increases markedly. The main nated by Na and Cl, increases markedly. The main processes controlling the geochemical evolution of groundwater in the basin-fill aquifer were identified using major-ion chemistry, mass balance calculations, thermodynamic calculations, stable isotopes, and mineral identification. These processes are: (1) dissolution of volcanic tuff and tuff-derived basin-fill deposits; (2) cation exchange of Ca and Mg in the water for Na in clay minerals; (3) weathering of plagioclase to montmorillonite; (4) precipitation of zeolite minerals; (5) concentration of dissolved constituents by evapotranspiration; (6) dissolution of Cl and SO4 evaporative salts; and (7) precipitation of calcite. (Author's abstract)

W91-11392

REFINEMENT OF THE COMBINATION EQUATIONS FOR EVAPORATION. National Oceanic and Atmospheric Administration, Princeton, NJ. Geophysical Fluid Dynamics

Lao. P. C. D. Milly. Surveys in Geophysics SUGEEC, Vol. 12, p 145-154, 1991. 1 tab, 13 ref.

Descriptors: \*Evaporation, \*Mathematical equations, Air temperature, Mathematical analysis, Mathematical studies, Performance evaluation,

Most combination equations for evaporation rely on a linear expansion of the saturation vapor pres-sure curve around the air temperature. Because the sme curve around the air temperature, because the temperature by several degrees, and because the saturation vapor pressure curve is nonlinear, this approximation leads to a certain degree of error in those evaporation equations. It is possible, however, to introduce higher order polynomial approximations for the saturation vapor pressure curve and to derive a family of explicit equations for evaporation, having any desired degree of accuracy. Under the linear approximation, the new family of equations for evaporation reduces, in particular cases, previously derived combination equations. Comparison of the linear and quadratic approximations leads to a simple approximate expression for the error associated with the linear case. Equations based on the conventional linear approximation consistently underestimate evaporation, sometimes temperature at the surface may differ from this consistently underestimate evaporation, sometimes by a substantial amount. (Author's abstract) W91-11398

GROUND-WATER CONTROL OF EVAPORITE DEPOSITION.

Geological Survey, Reston, VA. W. W. Wood, and W. E. Sanford. Economic Geology, Vol. 85, p 1226-1235, 1990. 8 fig, 4 tab, 26 ref.

Descriptors: \*Closed basins, \*Evaporation, \*Geochemistry, \*Groundwater movement, \*Minerals, \*Model studies, \*Seepage loss, \*Solutes, Advection, Closed systems, Computer models, Diffusion, Drilling, Fluctuations, Precipitation

An analytical, lumped parameter, solute mass bal-ance model is developed to define the concept of a groundwater flux ratio as it applies to topographi-cally closed basins in which evaporation exceeds precipitation. The presence or absence of glauber-ite, mirabilite, halite, bloodies, excluding and precipitation. The presence or absence or gautoer-tie, mirabilite, halite, bloedite, polyhalite and hexa-hydrite, caused by subtle changes in the ground-water seepage is illustrated using an example from the Southern High Plains of Texas and New the Southern High Plains of Texas and New Mexico. However, this model is general and is applicable with any solute composition including that of seawater and the use of surface rather than groundwater. Diffusion, advection, and density-driven flow are mechanisms by which solutes can escape to the groundwater from these closed hasing. The geochemical reaction computer proescape to the groundwater from these closed basins. The geochemical reaction computer program PHRQPITZ is used to document the effects of various flux ratios on the mineralogy and thickness of deposits. It was determined that groundwater flux ratios can have a profound effect on the suite of minerals that forms in an evaporative basin and that large thicknesses of only one or two minerals can be deposited under steady state conditions. Solute analyses used in conjunction with the tions. Solute analyses used in conjunction with the model can be used to screen prospective basins as well as to provide insights for exploratory drilling programs. (Author's abstract) W91-11438

CHEMICAL COMPOSITION OF LATE- AND POST-GLACIAL SEDIMENTS (FE, MN, P, C, N, N, H AND BSI) IN LAKE KLEINER BARSCH-SEE, A BOG LAKE IN THE NORTH OF GDR (DIE CHEMISCHE ZUSAMMENSETZUNG DER SPAT- UND POSTGLAZIALSEDIMENTE DES KLEINEN BARSCH-SEES (FE, MN, P, C, N, H UND BSI), EINES DYSTROPHEN MOOR-VEIHERS IM NORDEN DER DDR).

Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.

For primary bibliographic entry see Field 2H. W91-11518

SEDIMENT DENITRIFICATION POTENTIAL IN THE ELIZABETH RIVER, VIRGINIA.
Old Dominion Univ., Norfolk, VA. Dept. of Bio-

For primary bibliographic entry see Field 5C. W91-11537

BUDGETS OF SELECTED CATIONS AND ANIONS IN TWO FORESTED EXPERIMEN-TAL WATERSHEDS IN CENTRAL GREECE. Forest Research Inst., Athens (Greece). For primary bibliographic entry see Field 4C. W91-11550

#### 2L. Estuaries

EFFECT OF COASTAL SEA LEVEL FORCING ON INDIAN RIVER BAY AND REHOBOTH BAY, DELAWARE.

Delaware Univ., Newark. Coll. of Marine Studies.

Estuarine, Coastal and Shelf Science ECSSD3, Vol. 32, No. 3, p 213-229, March 1991. 6 fig, 1 tab, 14 ref. NOAA, Office of Sea Grant NA86AA-D-

Descriptors: \*Bays, \*Coastal environment, \*Dela-ware, \*Model studies, \*Sea level, \*Water level fluctuations, Coastal waters, Computer models, Indian River Bay, Pumping mode model, Reho-both Bay, Water level.

Previous studies have suggested that sea level and current variability in Indian River Bay and Reho-both Bay, Delaware are primarily forced by coast-al sea level fluctuations. A linearized frequencyal sea level fluctuations. A linearized frequency-dependent pumping mode model was developed to examine the response characteristics of the Indian River Bay-Rehoboth Bay system, and to assess the relative importance of the coastal forcing from the Indian River Inlet and the Lewes-Rehoboth Canal. The results indicated that the pumping mode model can adequately address the first-order response of the two bays. The results further indicate that sea level variabilities in the two bays are almost entirely caused by coastal forcing from the Indian River Inlet at both tidal and subtidal frequencies. The coastal forcing from the inlet also dominates the volume flux through the system at all frequencies, but the coastal forcing conveyed through the Lewes and Rehoboth Bay can generate up to 20% of the total volume transport at very ate up to 20% of the total volume transport at very low frequencies. The low-frequency volume flux low frequencies. The low-frequency volume flux through the canal, however, generates a flow through the entire system and produces minimal sea level response. The overall response of the two bays to coastal forcing depends strongly on the degree to which the two bays acts as an effective low-pass filter to preferentially damp out high-frequency tidal motions in Rehoboth Bay. Because of the coupled nature of the response, the ditch also exerts substantial influence on the response characteristics of Indian River Bay. (Author's abstract) stract) W91-10494

SEASONAL VARIATION OF BIOMASS AND PRODUCTION DYNAMICS FOR ABOVE AND BELOWGROUND COMPONENTS OF A SPAR-TINA ALTERNIFLORA MARSH IN THE EU-HALINE SECTOR OF PARANAGUA BAY (SE

Universidade Federal do Parana, Curitiba (Brazil).

Universidade Federal do Parana, Curitiba (Brazil). Centro de Biologia Marinha. P. C. Lana, C. Guiss, and S. T. Disaro. Estuarine, Coastal and Shelf Science ECSSD3, Vol. 32, No. 3, p 231-241, March 1991. 6 fig, 2 tab, 35 ref. Brazilian Nation Research Council grants 301532/84-2 and 820117/87-C.

### Estuaries—Group 2L

Descriptors: \*Bays, \*Brazil, \*Cord grasses, \*Marsh plants, \*Primary productivity, \*Salt marshes, \*Seasonal variation, \*Wetlands, Biomass, Ecology, Growth, Mangrove trees, Paranagua Bay, Plant growth, Productivity.

The seasonal variation of biomass and the annual net primary production for aboveground and belowground components of Spartina alterniflora Loisel intermediate form were evaluated by harvest methods over a 14-month period in Paranagua Bay (SE Brazil). Belowground components were characterized by a larger biomass, ranging from 172 +/48 g/square m at the end of summer to 569 +/-211 g/square m in late spring. The biomass of live aboveground tissue was usually higher than dead tissue, ranging from 51 +/-21 g/square m in winter to 116 +/-36 g/square m in summer. The overall mean root to shoot ratio was 4.8, ranging from 1.7 in summer to 8.5 in late spring, reflecting storage and translocation events. Net belowground primary production was 358 g/square m/year, largely exceeding aboveground production, which ranged from 101 to 179 g/square m/year, depending on how data were handled. Turnover of above and belowground material, expressed by a production to maximum biomass ratio, was fast, ranging from 0.66 to 1.52 years. In comparison with temperate Spartina marshes, the low productivity and low biomass of marshes of the high-energy sector of Paranagua Bay are probably a result of different growth strategies, high salinities and fast sediment accretion, which usually lead to their ultimate replacement by mangroves. (Author's abstract)

# IODINE CHEMISTRY IN THE WATER COLUMN OF THE CHESAPEAKE BAY: EVIDENCE FOR ORGANIC IODINE FORMS.

Delaware Univ., Lewes. Coll. of Marine Studies. G. W. Luther, T. Ferdelman, C. H. Culberson, J. Kostka, and J. Wu.

Estuarine, Coastal and Shelf Science ECSSD3, Vol. 32, No. 3, p 267-279, March 1991. 3 fig, 2 tab, 24 ref. NSF grants OCE-8696121, OCE-8916804, and OCE-8541747.

Descriptors: \*Chesapeake Bay, \*Iodides, \*Iodine, \*Water chemistry, Anoxic conditions, Bays, Oxygen, Primary productivity, Sulfur compounds, Water pollution, Water quality, Water sampling.

During the summer of 1987, Chesapeake Bay water samples were collected for the inorgan iodine species: iodide (by cathodic-stripping square-wave voltammetry) and iodate (by differential pulse polarography); and total iodine (by hypo-chlorite oxidation of the seawater sample to iodate). The difference between the sum of the inorganic iodine species and the total iodine was significant for about one-third of the samples collected from the Bay. Thus, in these samples, a third (or more) new form of iodine was present. These samples were primarily from oxygen-saturated surface waters of high biological activity (primary productivity and bacterial processes). This new face waters or ingn biological activity (primary productivity and bacterial processes). This new form can make up as much as 70% of the total iodine. Waters containing low oxygen concentrations showed less of this new form of iodine whereas anoxic and sulfidic bottom waters contained only iodide. This new form of iodine is organic in nature and probably non-volatile. It may organic in nature and protoatory non-votature. It may reside in the peptide and humic fractions. Only reduced iodine (iodide and organic iodine) was detected in waters from the northern section of the Bay, whereas only iodide and iodate were detected in the southern section of the Bay. In only two samples were iodide, iodate and the new form of iodine found to coexist. Iodide and organic iodine are probably cycled in the surface waters of the northern section of the Bay via a combination of biogeochemical and photochemical processes which produce the reactive intermediates, molecular iodine and hypoidous acid. These react quickly with reduced inorganic and organic compounds to maintain the reduced forms of iodine in the water column. Only total iodine is conservative through-out the estuary. The inorganic iodine forms can be used as geochemical tracers. (Author's abstract) W91-10496

MACROALGAL-SEDIMENT NUTRIENT INTERACTIONS AND THEIR IMPORTANCE TO MACROALGAL NUTRITION IN A EUTRO-PHIC ESTUARY.

Western Australia Univ., Nedlands. Centre for Water Research.

P. S. Lavery, and A. J. McComb.
Estuarine, Coastal and Shelf Science ECSSD3,
Vol. 32, No. 3, p 281-295, March 1991. 9 fig, 1 tab,
25 ref.

Descriptors: \*Algae, \*Algal growth, \*Cycling nutrients, \*Estuaries, \*Eutrophic estuaries, \*Nutrients, \*Sediment-water interfaces, Ammonium, Eutrophication, Nitrogen, Nutrient transport, Oxygen, Phosphates, Seasonal variation, Sediment analysis, Water quality.

The potential for algal banks to influence water quality and sediment nutrient flux was examined through laboratory experiments and in situ monitoring of algal banks. Loose macroalgal banks displayed seasonal changes in tissue nutrient concentrations suggesting a strong dependence on water column nutrients. These banks fail to generate conditions suitable to sediment nutrient release. Dense banks generated low oxygen conditions in the inter-algal water (0-1 mg/L), corresponding to zones of high, and relatively stable, phosphate and ammonium concentrations (up to 96 microgram/L PO4-P and 166 microgram/L NH4-N). Laboratory experiments confirmed that macroalgal banks can generate reducing conditions at the sediment surface, regardless of the aeration regime, through the decomposition of macroalgal tissue. Platinum electrode potentials as low as -200 millivolts were recorded in the inter-algal water. In such banks, redox-dependent sediment nutrient release and anaerobic accumulation of nitrogen accounted for inter-algal nutrient concentrations of over 60 microgram/L phosphate and 800 microgram/L ammonium. The generation of reducing conditions in inter-algal water required 7 days of still conditions and so this mechanism of nutrient generation is unlikely to be important in winter, when strong winds frequently shift the algal banks. It is suggested that in summer this mechanism may provide a source of nutrients to dense algal banks, supplementing reserves stored in winter. (Author's abstract)

#### FIRST-ORDER ORGANIC CARBON BUDGET IN THE ST LAWRENCE LOWER ESTUARY FROM 13C DATA.

Quebec Univ., Montreal.
M. Lucotte, C. Hilliaire-Marcel, and P. Louchouarn.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 32, No. 3, p 297-312, March 1991. 7 fig, 2 tab, 36 ref.

Descriptors: \*Estuaries, \*Isotope studies, \*Organic carbon, \*Sediment transport, \*St Lawrence Estuary, Algal blooms, Carbon, Particulate matter, Phytoplankton, Seasonal variation, Zooplankton.

Carbon isotope ratios and concentrations of suspended particulate matter and surface sediments of the Lower St. Lawrence Estuary were used to determine the seasonal fluxes of particulate organic matter to the estuarine floor. Light carbon particles brought by the St Lawrence River during spring freshet are carried to the intermediate and deep watermasses of the Lower Estuary until July. In contrast, heavy loads of 13C-enriched particles in the surface waters at the head of the Laurentian Channel are directly attributable to the early summer phytoplankton bloom or indirectly to the related zooplankton populations. Only small amounts of terrigenous particles from the turbid zone are still found in the early fall water column. All particles have a short residence time of a few days within the St Lawrence Estuary, limiting most seaward export. The surface sediments of the Lower Estuary have an average C-isotope composition of -22.4 parts per thousand. Using a simple two-components 13C-missing equation, this value represents 43 +/-8% of terrigenous and 57 +/-8% of marine particulate organic carbon. A first-order carbon budget was then derived from published sedimentation rates and primary production

estimates. About 75% of the terrigenous particulate organic matter introduced in the Upper Estuary is deposited within the limits of the Lower Estuary. Simultaneously, the equivalent of less than 30% of the annual phytoplanktonic carbon production in the Lower Estuary reaches the estuarine floor, mostly under the form of copepod fecal pellets. Over 70% of the photosynthesized carbon is biodegraded and recycled in the water column. (Author's abstract)

#### NEW DEAD SEA.

For primary bibliographic entry see Field 5C. W91-10504

#### MANAGING OREGON'S ESTUARINE RE-SOURCES LANDS.

Oregon State Univ., Corvallis. Dept. of Geosciences.

P. L. Jackson. Journal of Soil and Water Conservation JSWCA3, Vol. 46, No. 1, p 23-26, January/February 1991. 2 tab, 2 fig, 17 ref.

Descriptors: \*Coastal zone management, \*Estuaries, \*Oregon, \*Wetlands, Coasts, Land use, Marshes, Restoration, Water law, Water policy, Wetland mitigation.

Resource planning is a major feature of Oregon's coastal zone management program. Estuarine mitigation has become an important phase in the planning and management of the state's coastal wetlands. The preservation and conservation of important estuarine habitat is balanced with water-related development through a coordinated program of local comprehensive planning, land use regulation, and waterway alteration laws. As part of this program, mitigation banking is used to maintain the integrity of estuarine ecosystems by restoring or enhancing substitute habitat where planned development would otherwise result in the loss of resource lands. Estuarine mitigation has received widespread attention as a means of resolving some of the problems inherent in balancing conservation and development in coastal wetlands. The idea of creating or restoring substitute habitat in exchange for habitat lost to development has intuitive appeal. Clearly, mitigation is not viewed as the complete solution to the wetlands conversion issue. Marsh restoration and creation technology has not progressed to the point of certainty of results. Recognizing these issues, the Oregon coastal zone management program relies on mitigation as a final requirement at the end of an extensive decision-making process. (Mertz-PTT)

#### EFFECTS OF POLLUTION ON HETEROZY-GOSITY IN THE BARNACLE BALANUS AM-PHITRITE (CIRRIPEDIA: THORACICA).

Padua Univ. (Italy). Dept. of Biology. For primary bibliographic entry see Field 5C. W91-10518

# METEOROLOGY AND OCEANOGRAPHY IN THE SETO INLAND SEA.

Kobe Marine Observatory (Japan). K. Nishiyama, T. Yano, H. Suzuki, and H. Iida. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 5-9, 1991. 12 fig. 2 tab. 9 ref.

Descriptors: \*Climates, \*Fog, \*Japan, \*Meteorology, \*Oceanography, \*Path of pollutants, \*Precipitation, \*Seto Inland Sea, \*Wind, Boundary layers, Coastal waters, Comparison studies, Dissolved oxygen, Estuaries, Nutrient concentrations, Salinity, Vertical mixing, Water temperature, Water transport.

On the Seto Inland Sea (SIS), westerly winds generally prevail, and complex land and sea breezes occur, due to the land morphology. The region has less precipitation and more sunshine than any other in Japan. Sea fogs occur from March to August. River discharge is greater in the eastern part of the SIS. These meteorological and

#### **Group 2L—Estuaries**

oceanographic factors control water mass genera-tion, diffusion of pollutants, and biological activi-ties in the SIS. Mean eastward water transport occurs via westerly winds. Generally, tidal cur-rents predominate, especially in straits, where cur-rents are rapid and vertical mixing is strong. The sea level is highest in Bisan Seto of the SIS, where sea surface temperature and salinity are relatively low. Bisan Seto appears to be the boundary between the eastern and western areas of the SIS. The nutrient concentration in the SIS increased between the 1930's and 1970's, but remained level oetween the 1930s and 1970s, but remained level since then. Water exchanges between the SIS and the Kuroshio occur in Bungo Channel and Kii Channel. In Kii Channel, the easternmost of the SIS, the coastal water appears to flow offshore in the upper layer, and the modified Kuroshio water appears to flow into Osaka Bay in the lower layer, as determined by observed water temperature, sa-linity, and dissolved oxygen profiles. (Author's ab-W91-10520

RUNOFF CHARACTERISTICS OF COD, BOD, C, N, AND P LOADINGS FROM RIVERS TO ENCLOSED COASTAL SEAS.

National Inst. for Environmental Studies, Tsukuba (Japan). Water and Soil Environment Div. For primary bibliographic entry see Field 5B. W91-10521

WATER QUALITY MANAGEMENT ISSUES IN LINGAYEN GULF, PHILIPPINES AND SOME PROPOSED SOLUTIONS. International Center for Living Aquatic Resources

Management, Manila (Philippines).
For primary bibliographic entry see Field 5G.
W91-10523

OUTFLOW AND THREE-DIMENSIONAL SPREADING OF RIVER WATER IN EN-CLOSED BAY.

Osaka Univ. (Japan). Dept. of Civil Engineering. K. Nakatsuji, N. Yamamoto, and K. Muraoka. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 31-35, 1991. 5 fig, 7 ref.

Descriptors: \*Bays, \*Dispersion, \*Mathematical models, \*Model studies, \*Path of pollutants, \*Rivers, \*Stream discharge, Coastal waters, Gravity flow, Osaka Bay, Plumes, Pressure distribution, Satellite technology, Water quality, Yodo River.

Physical processes of outflow and gravitational spreading of the Yodo River in the Osaka Bay can be explained by means of a three-dimensional, primitive equation model. The river water spreads primitive equation mode. The river water spreads out over the sea water, controlled by horizontal pressure gradients resulting from density differ-ences. On a horizontal length scale on the order of the Rossby deformation radius, the earth's rotation exerts a strong influence on river water outflow behavior. The results of the model predictions compare well with the satellite infrared image. Model results indicate that the deformation of the outflow pattern and the formation of a coastal current are unique features of river plume spreading in cases of high river discharges. Since the ing in cases of high river discharges. Since the water quality of enclosed bays depends largely on the input of pollutants through rivers, understanding of the outflow dynamics of river plumes is important. (Author's abstract) W91-10525

CIRCULATION AND POLLUTANT DISPER-SION IN MASAN-JINHAE BAY OF KOREA. Korea Ocean Research and Development Inst., Seoul (Republic of Korea).

For primary bibliographic entry see Field 5B. W91-10526

WATER EXCHANGE AND TRANSPORT OF MATTER IN THE SETO INLAND SEA. Ehime Univ., Matsuyama (Japan). Dept. of Ocean

eering. H. Takeoka. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 41-44, 1991. 3 fig. 3 tab, 6 ref. Descriptors: \*Coastal waters, \*Japan, \*Mathemati-cal models, \*Model studies, \*Nutrient transport, \*Organic loading, \*Seto Inland Sea, \*Water chem-istry, \*Water exchange, Channels, Flow discharge, Nitrogen, Nutrient concentrations, Residence time, Rivers, Upwelling, Vertical mixing.

Enclosed coastal seas are regarded as transport systems with a flux of concentrated matter and a standing stock in the coastal sea. Mechanisms de standing stock in the coastas sea. Mechanisms de-termining the average residence time (ART) of the nitrogen in the Seto Inland Sea, Japan, are exam-ined by using a simple numerical model. Since the Seto Inland Sea is a long channel, it can be simplified horizontally to a one-dimensional channel of 500 km long. The flow in the channel is directed outward in the upper layer and inward in the lower layer. Since the river discharge is larger in the eastern part of the inland sea, the center of the the eastern part of the initial sea, the center of the upwelling is assumed to be located in the eastern part. The ART of the nitrogen is larger than that of the riverine water by about twice, due to the coupled effect of the flow having a vertical shear and biochemical processes. Strong vertical mixing at the straits reduces the ART of the nitrogen. Mixing through Naruto Strait also effectively reduces the ART of the nitrogen. The coupled effect of the flow's vertical shear and the biochemical processes makes the ART of the nitrogen layer larger than that of the riverine water or of other permanently dissolved matter. Strong vertical mixing at the straits reduces the ART of the nitrogen. Mixing through Naruto Strait also effectively reduces the ART of the nitrogen. (Brunone-PTT)

NUMERICAL SIMULATION OF WATER QUALITY IN TOKYO BAY.
Japan NUS Co. Ltd., Osaka.
For primary bibliographic entry see Field 5B.
W91-10528

FIELD SURVEY AND HYDRAULIC STUDY OF 'AOSHIO' IN TOKYO BAY.

National Inst. for Environmental Studies, Tsukuba (Japan). For primary bibliographic entry see Field 5C. W91-10529

NORTH SEA STRATEGIES.

Ministry of Transport and Public Works, The Hague (Netherlands). Tidal Waters Div. For primary bibliographic entry see Field 5G. W91-10530

5-YEAR SCIENTIFIC RESEARCH PRO-GRAMME FOR MANAGING COASTAL SEAS. Proudman Oceanographic Lab., Birkenhead (England). D. Prandle.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 63-66, 1991. 1 fig.

Descriptors: \*Coastal waters, \*Mathematical models, \*Model studies, \*North Sea, \*Oceanography, \*Path of pollutants, \*Research priorities, models, "Model studies, "North Sea, "Oceanogra-phy, "Path of pollutants, "Research priorities, "Water pollution control, "Water resources man-agement, Coastal zone, Estuaries, Global warming, International agreements, Prediction, Rivers, Sea level, Seasonal variation, Suspended sediments, United Kingdom, Water quality monitoring.

The management of coastal seas requires scientific knowledge to link inputs to resulting concentra-tions; to distinguish between natural variability and tions; to distinguish between natural variability and man's impact; and, to predict long-term trends. This knowledge incorporates movement and dis-persion of both water and sediments, partitioning of contaminants between dissolved and particulate phases, and successive exchange processes between river/estuary/coastal zone/sea/ocean and between sea/seabed and sea/atmosphere. The UK is presently midway into a five-year, fifteen million pounds oceanographic research program in the North Sea involving the development of numerical models, systematic observations and fundamental research to fill gaps in basic knowledge. The program will proceed through three stages, simulating physical, biological, chemical and sedimentological

parameters over the well-defined seasonal cycle, over inter-annual variations, and for long-term trends. Long-term data sets are vital for such protrends. Long-term data sets are vital for such programs, using systematic marine monitoring programs involving combinations of remote sensing, sea-truth moorings, and coastal stations. This program will be extended to consider the contribution to and effect from global pollution, specifically possible greenhouse effects, such as a rise in mean sea level and meteorological changes. The wide-spread impact of such phenomena emphasizes the necessity for international cooperation in all aspects of these studies. (Author's abstract) W91-10531 W91-10531

INVESTIGATION ON TURBIDITY AND FLOW PATTERNS IN HALF-CLOSED SEA AREA. Chemical Inst. for Industry, Tsukuba (Japan). For primary bibliographic entry see Field 5B. W91-10532

FLUIDIZATION OF MARINE MUD BY

California Univ., Berkeley. Dept. of Civil Engineering. For primary bibliographic entry see Field 5B.

WATER QUALITY ASSESSMENT AND PRO-TECTION MEASURES OF A SEMI-ENCLOSED COASTAL AREA: THE BAY OF THERMAIKOS (NE MEDITERRANEAN SEA).

Thessaloniki Univ., Salonika (Greece). Lab. of Hydraulics and Hydraulic Works. For primary bibliographic entry see Field 5G. W91-10534

EUTROPHICATION IN HIROSHIMA BAY. Hiroshima Prefectural Research Center for Environmental Science (Japan). For primary bibliographic entry see Field 5B. W91-10536

HEAVY METAL POLLUTION IN SEDIMENT FROM THE SETO INLAND SEA, JAPAN. Government Industrial Research Inst., Chugoku, For primary bibliographic entry see Field 5B. W91-10537

SCAVENGING PROCESSES OF MARINE PAR-TICLES IN OSAKA BAY. Kagawa Univ., Miki (Japan). Faculty of Agricul-

For primary bibliographic entry see Field 5B. W91-10538

CHANGE OF OCEANIC CONDITION BY THE MAN-MADE STRUCTURE FOR UPWELLING. Ehime Univ., Matsuyama (Japan). Dept. of Ocean Engineering.

For primary bibliographic entry see Field 8I. W91-10542

EFFECT OF A SPRING PHYTOPLANKTON BLOOM ON DISSOLVED COPPER SPECIATION IN BEDFORD BASIN.

Dalhousie Univ., Halifax (Nova Scotia). Dept. of Oceanography.
For primary bibliographic entry see Field 5B.
W91-10543

IMPACT OF NUTRIENT ENRICHMENT AND THEIR RELATION TO THE ALGAL BLOOM IN THE ADRIATIC SEA. Institute of Oceanography and Fisheries, Split

(Yugoslavia). For primary bibliographic entry see Field 5C. W91-10544

SUMMARY OF PORTS AND MARINE ENVI-RONMENT IMPROVEMENT WORK AND EX-

# Estuaries—Group 2L

AMPLE OF LATEST MEASURES IN SETO INLAND SEA.
Ministry of Transport, Kobe (Japan). 3rd District Port Construction Bureau.
For primary bibliographic entry see Field 5G.
W91-10545

GROWTH POTENTIALS OF RED TIDE PHY-TOPLANKTERS IN COASTAL SEAWATER BY

AGP ASSAY.

Kochi Univ. (Japan). Faculty of Agriculture.

For primary bibliographic entry see Field 5A.

W91-10548

BLOOM OF COSCINODISCUS WAILESII AND DO DEFICIT OF BOTTOM WATER IN SETO INLAND SEA.

Hyogo Prefectural Fisheries Experimental Station, Akashi (Japan).

For primary bibliographic entry see Field 5C. W91-10549

RECOVERY OF AQUATIC ANIMALS IN DOKAI BAY, NORTHERN KYUSHU, JAPAN. Kitakyushu Municipal Inst. of Environmental Health Sciences (Japan). For primary bibliographic entry see Field 5G. W91-10550

INTRODUCED SPECIES--RESOURCE OR THREAT IN BRACKISH-WATER SEAS: EXAM-PLES FROM THE BALTIC AND BLACK SEA. Abo Akademi, Turku (Finland). Dept. of Biology.

E. J. Leppakoski.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 219-223, 1991. 1 fig, 26 ref.

Descriptors: \*Baltic Sea, \*Black Sea, \*Brackish water, \*Coastal areas, \*Introduced species, Bivalves, Ecosystems, Inland waterways, Invasions, Life cycles, Mollusks, Phaeophyta, Polychaetes, Population dynamics, Species diversity.

Species introductions into marine and brackish-water systems were not studied systematically prior to the 1950's. Enclosed seas, such as the Black Sea and the Baltic, can be regarded as dis-junct 'brackish-water islands', with an impover-ished flora and fauna, locked in by land and isolat-ed from other major brackish-water bodies by physical (ocean and land) barriers. The four suc-cessive stages of invasions are arrival, establish-ment, spread and persistence. Hundreds of intro-duced species have arrived (many of them by merduced species have arrived (many of them by mere chance) into the brackish Black and Baltic Seas, or their coastal ecosystems, as planktonic larvae in ballast water tanks, as sessile organisms attached to hulls, or as benthic stages living in (or on) the sediment settled on the bottom of the tanks, or have been introduced intentionally. Most of them have been unable to maintain a self-sustaining population and thus only small numbers of these spe-cies have become established in these seas, and still fewer have been able to spread on a sea-wide basis. Mya arenaria has persisted in northwest European waters for 300 to 400 years, in the Black Sea for waters for 300 to 400 years, in the Biack Sea for not more than 30 years to the present. Balanus improvisus has been very successful in the Baltic Sea since the late 1800's. Examples of the latest newcomers from northeast European seas into the Baltic are the American jackknife clam Ensis directus, the spionid polychaete Merenzelleria viridis, and the brown alga Sargassum muticum. An example from the Black Sea of recent introductions is the bivalve Cunearca cornea. Since all vessels destined for any Baltic or Black Sea harbor have to pass fully marine waters with oceanic salinities, a relatively simple and cheap method of seducing relatively simple and cheap method of reducing the risk of unintentional introductions of estuarine species into these enclosed brackish-water seas would be a mid-ocean exchange of ballast water en-route. (Brunone-PTT) W91-10552

EASTERN MEDITERRANEAN: A MARINE

Centre for Research in Environmental and Water Resources Engineering, Haifa (Israel).

For primary bibliographic entry see Field 2H. W91-10553

BENTHIC FAUNAL SUCCESSION IN A COVE ORGANICALLY POLLUTED BY FISH FARM-

Kumamoto Women's University, Mizuarai 2432-1, Kengun-machi, Kumamoto, 862 Japan. For primary bibliographic entry see Field 5C. W91-10554

MARICULTURE AND EUTROPHICATION IN

JINHAE BAY, KOREA.

Department of Aquaculture, Tong-yeong Fisheries
Technical College, Chungmu 650-160, Korea.
For primary bibliographic entry see Field 5B.
W91-10558

EGYPTIAN APPROACH TOWARDS APPROPRIATE USE OF COASTAL ZONES ON THE

Egyptian Environment Affairs Agency, Cairo. For primary bibliographic entry see Field 6G. W91-10561

IMPACT OF COASTAL DEVELOPMENT ON THE INFRALITTORAL ZONE ALONG THE SOUTHEASTERN MEDITERRANEAN SHORE OF CONTINENTAL FRANCE.
Nice Univ. (France). Marine Environment Lab. For primary bibliographic entry see Field 6G. W91-10562

KANSAI INTERNATIONAL AIRPORT PROJECT AND ENVIRONMENTAL IMPACT ASSESSMENT.
Coordination Department, Kansai International Airport Co., Ltd, 3-11-10 Minami-senba, Chuo-ku, Osaka, 542 Japan.
For primary bibliographic entry see Field 4C.
W91-10563

MODERN ENVIRONMENTAL ASSESSMENT PROCEDURES FOR ENCLOSED SEAS. Waikato Univ., Hamilton (New Zealand). Dept. of

Earth Sciences For primary bibliographic entry see Field 6G. W91-10564

TOWARD ENVIRONMENTAL PLANNING FOR EAST ASIAN ESTUARIES: JAPANESE AND CHINESE ENCLOSED BAYS.

Osaka Geijutsu University, Department of Environmental Planning, Osaka Prefecture, 585 Japan. H. A. Shapiro. Marine Pollution Bulletin MPNBAZ, Vol. 23, p

363-368, 1991. 6 fig, 4 tab, 10 ref.

Descriptors: \*China, \*Coastal zone management. Peconomic development, \*Environmental impact, \*Environmental protection, \*Estuaries, \*Japan, Ecosystems, Environmental impact statement, Hazards, Human population, Path of pollutants, Planning, Primary productivity, Water pollution.

East Asia consists of several nations each in different stages of economic development, from developing, to newly developed, to advanced industrial. In almost every case, the coastal zones of these nations are highly biologically productive. However, at the same time, they are vulnerable to natural hazards, with enclosed coastal waters particularly vulnerable to pollution. Tokyo Bay, one of Japan's foremost important and productive estuarine ecosystems, is located in the Kanto area of eastern Japan. Hazard-related criteria, such as earthquake vulnerability, flood vulnerability, marine explosions, and fire, were compiled. Aesthetically and culturally valuable areas were mapped. Finally natural and human-health-related criteria were all mapped at a common scale. Water-related criteria were combined to identify areas where land and East Asia consists of several nations each in differmapped at a common scale, water-related criteria were combined to identify areas where land and water have mutually strong impacts on each other. In order to protect the quality of the environment of these areas, especially the pollution and hazard-vulnerable, highly biologically productive en-

closed coastal areas, an environmentally sensitive approach to sustainable development appears to be a fundamental necessity. (Brunone-PTT) W91-10565

ECOLOGICAL ASSESSMENT OF SEMI-EN-CLOSED MARINE WATER BODIES OF THE ARCHIPELAGO SABANA-CAMAGUEY (CUBA) PRIOR TO TOURISM DEVELOPMENT PRIOR TO PROJECTS.

Instituto de Oceanologia, Havana (Cuba).
For primary bibliographic entry see Field 6G. W91-10566

STUDY ON MODEL REFERENCE ADAPTIVE WATER POLLUTION CONTROL IN EN-CLOSED COASTAL SEA.

Hokkaido Univ., Sapporo (Japan). Graduate School of Environmental Science. For primary bibliographic entry see Field 5G. W91-10567

STRATEGIES FOR RESTORING AND DEVEL-OPING FISH HABITATS IN THE STRAIT OF GEORGIA: PUGET SOUND INLAND SEA, NORTHEAST PACIFIC OCEAN.

Department of Fisheries and Oceans, Vancouver (British Columbia). West Vancouver Lab. For primary bibliographic entry see Field 5G. W91-10568

ASSESSMENT OF THE ENVIRONMENTAL CAPACITY OF ENCLOSED COASTAL SEA. Zagreb Univ. (Yugoslavia). Faculty of Civil Engi-

For primary bibliographic entry see Field 5E. W91-10571

ENVIRONMENTAL MANAGEMENT OF THE SETO INLAND SEA.

Hygo Prefectural Public Health and Environ-ment Dept., Kobe (Japan). For primary bibliographic entry see Field 5G. W91-10573

INTERNATIONAL PROGRAMME FOR THE PROTECTION OF A SEMI-ENCLOSED SEA: THE MEDITERRANEAN ACTION PLAN.

nme, Athens United Nations Environment Programme, Athens (Greece). Co-ordinating Unit for the Mediterranean Action Plan.

For primary bibliographic entry see Field 5G. W91-10574

ENVIRONMENTAL RESEARCH, POLICY AND REGULATION: THE CHESAPEAKE BAY EXPERIENCE.

Maryland Univ., Cambridge. Center for Environmental and Estuarine Studies.

For primary bibliographic entry see Field 5G.
W91-10575

NON-REGULATORY APPROACHES TO MAN-AGEMENT OF COASTAL RESOURCES AND DEVELOPMENT IN SAN FRANCISCO BAY. California State Coastal Conservancy, Oakland. P. Grenell.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 503-507, 1991, 6 ref.

Descriptors: \*California, \*Coastal zone management, \*Regulations, \*San Francisco Bay, \*Water resources management, Agriculture, California State Coastal Conservancy, Dikes, Land use, Port facilities, Wastewater disposal, Water quality control, Wetlands.

San Francisco Bay is the largest coastal water body in California. Many large, enclosed water bodies in other countries are likely to experience some of the Bay's problems. The management of the Bay's coastal resources may be relevant for other nations now facing similar problems. The Bay Area's resources are regulated by three main

#### **Group 2L—Estuaries**

agencies: the San Francisco Bay Conservation and Development Commission, the United States Army Corps of Engineers, and the regional water quality control boards. In addition to these, numerous others exercise other limited regulatory, planning, or advisory functions. In particular, the California State Coastal Conservancy's (CSCC) experience as a non-regulatory problem-solving agency may be pertinent to situations which either have may be pertinent to situations which either have similar complex regulatory systems as the Bay Area, or which face problems not amenable to regulatory solutions. The CSCC was created in regulatory solutions. The CSCC was created in 1973 with a broad mandate: to protect, restore and enhance coastal resources. The CSCC has been instrumental in protecting diked wetlands and agriculture, resolving multiple-use conflicts, experimental uses of treated wastewater in marsh enhancement, providing public access to the Bay Shore, and restoring the Bay's urban waterfronts. (Brunone-PTT) W91-10576

ENVIRONMENTAL MANAGEMENT OF THE PUGET SOUND

Puget Sound Water Quality Authority, Seattle, WA.

For primary bibliographic entry see Field 5G.

CONTROLLING EFFECT OF THE PLANNED MANAGEMENT OF THE ENVIRONMENT IN THE KAGOSHIMA BAY ON THE POLLUT-ANT LOAD.

ima Prefecture Environment Preservation Center (Japan). Dept. of Information Management. For primary bibliographic entry see Field 5G. W91-10579

INTEGRATED MANAGEMENT OF THE BALTIC SEA.

National Swedish Environment Protection Board, Solna.

For primary bibliographic entry see Field 5G. W91-10580

CONCEPTUAL FRAMEWORK OF ENVIRON-MENTAL MANAGEMENT STRATEGIES FOR YUGOSLAVIA: THE CASE OF THE ADRIATIC SEA.

Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research. For primary bibliographic entry see Field 5G. W91-10584

ENVIRONMENTAL ACTIVISM IN THE SAN FRANCISCO BAY ESTUARY.

San Francisco Estuary Project, P.O. Box 2050, Oakland, California. For primary bibliographic entry see Field 5G. W91-10585

ESTUARY PROGRAM AND PUBLIC INVOLVEMENT.

Environmental Protection Agency, Washington, DC. Office of Marine and Estuarine Protection. For primary bibliographic entry see Field 5G. W91-10590

EUTROPHICATION MECHANISMS OF COASTAL SEAS IN YAMAGUCHI PREFEC-

Yamaguchi Prefectural Research Inst. of Health (Japan).

For primary bibliographic entry see Field 5B. W91-10593

COMPARISON OF NUTRITIONAL ENVIRON-MENT OF CLOSED COASTAL SEAS IN WEST-ERN KYUSHU.

Seikai National Fisheries Research Inst., Nagasaki (Japan).

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 679-682, 1991. 5 fig, 1 tab, 9 ref.

Descriptors: \*Chlorophyll, \*Coastal waters, \*Eutrophication, \*Japan, \*Nutrients, Comparison studies, Human population, Imari Bay, Inorganic nitrogen, Kagoshima Bay, Seasonal variation.

Bays in western Kyushu face the open sea, and Bays in western Kyushu face the open sea, and have unique characteristics. Fukuoka Bay is surrounded by a big city, Imari Bay holds a large number of mariculture sites, and Kagoshima Bay is divided into two parts (a closed inner part and a semi-closed outer part). Data from Fukuoka indicated a relationship between high chlorophyll levels and low chlorophyll and high dissolved inorganic nitrogen in summer, and low chlorophyll and high dissolved. summer, and low chlorophyll and high dissolved inorganic nitrogen in the winter. Data from Imari Bay varied greatly. In Kagoshima Bay, dissolved inorganic nitrogen concentrations were similar beinorganic nitrogen concentrations were similar oc-tween the two parts, but chlorophyll values were distinctly higher in the inner part. The composition of nitrogen varied seasonally. These results were compared with data collected world-wide, and the results suggested that coastal water may increase cutropnication from equivalent dissolved inorganic nitrogen levels. These levels are probably caused by some organic enrichment from human activities. Characteristics of each bay seem to be consistently influenced by their social backgrounds and topographical features. (Author's abstract) W91-10595 eutrophication from equivalent dissolved inorganic

SEDIMENT TRANSPORT ON THE FORE-

Universidad Politecnica de Canarias, Las Palmas de Gran Canaria (Spain). Dept. of Physics.

I. Alonso. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 695-697, 1991. 4 fig, 6 ref.

Descriptors: \*Accretion, \*Beach profiles, \*Beaches, \*Coastal waters, \*Sediment transport, \*Sedimentation, \*Shorelines, \*Spain, Erosion, Las Palmas, Tidal effects, Tidal range.

Beach face profiles have been measured at El Hombre Beach (Las Palmas, Spain), a typical pocket beach 200 m in length and 100 m in width, between December 1988 and December 1989.
Changes in beach profiles have been related to the standard deviation, which is used to fix the berm position. Sand volume changes are related to the maximum tidal range. The central beach sector showed an end erosion of 50 cubic m/m. From the results, longshore transport appears to be very important on the beach. An increase in tidal range often corresponds with the erosion rate, and a decrease in tidal range results in accretion. (Brunone-PTT) W91-10599

POLLUTANT TRANSPORT MONITORING AND PREDICTION BY MATHEMATICAL MODELLING: NORTH SEA AND ADJACENT ESTUARIES.

GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik. For primary bibliographic entry see Field 5B. W91-10600

CONSTRUCTION OF ARTIFICIAL SEAWEED BED ACCOMPANIED WITH THE RECLAMATION FOR UNIT NO. 3 OF IKATA POWER

Shikoku Research Inst., Inc., Takamatsu (Japan). H. Yokouchi, R. Yamamoto, and Y. Ishizaki. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 719-722, 1991. 10 fig.

Descriptors: \*Algae, \*Aquatic habitats, \*Artificial substrates, \*Fish, \*Japan, \*Mollusks, Baseline studies, Environmental monitoring, Flow rates, Land reclamation, Powerplants, Species diversity, Transparency.

Seaweed beds provide good habitats for many organisms, including fish and shellfish, in Japan. Recently, natural seaweed beds have been reduced. due to the effects of seashore reclamation and marine pollution in the Seto Inland Sea. Construc-tion of artificial seaweed beds was proposed, as an environmental preservation measure, when Unit No. 3 of the Ikata Power Station was planned. Baseline studies, monitoring at 5, 10, 15, and 20 m depths, had been carried out for five years. The mean velocity of the water current was 0.07 to 0.16 m/sec at all monitored depths, and the transparency was 9.2 to 10.1 m. Sixty to eighty species of seaweds are found in the study area, and the species diversity on the artificial mounds was comparable to that of natural seawed beds. Based on the results, two mounds were piled in front of the station, and have provided comparable coverage to that of natural seawed beds, as predicted. (Brunone-PTT) W91-10603

SEASONAL CHANGES OF ORGANIC CARBON AND NITROGEN PRODUCTION BY PHYTOPLANKTON IN THE ESTUARY OF RIVER TAMAGAWA.

Saitama Univ., Urawa (Japan). Coll. of Liberal Arts.

For primary bibliographic entry see Field 5B. W91-10604

SUCCESSION OF BENTHIC ASSEMBLAGES IN WILD BIRD PARK, A SANCTUARY ESTAB-LISHED ON RECLAIMED LAND IN OSAKA

Osaka City Inst. of Public Health and Environ-

Osaka City Inst. of Public Health and Environ-mental Sciences (Japan). H. Yokoyama, T. Umehara, and K. Oda. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 739-742, 1991. 2 fig. 5 ref.

Descriptors: \*Aquatic habitats, \*Japan, \*Land reclamation, \*Osaka Port, \*Species diversity, \*Waterbirds, Amphipods, Biomass, Comparison studies, Intertidal areas, Lagoons, Seawater, Tidal flats.

The population of benthic animals and environmental parameters were surveyed in three areas (Marsh A, Marsh B, and the Lagoon) of Wild Bird Park, an area constructed on reclaimed land in Osaka Port, Japan, to obtain data to aid in increasing the numbers of prey organisms for shorebirds. ing the numbers of prey organisms for shorebirds. In Marsh A, formed by standing rainwater, marine benthic organisms intruded as seawater was introduced. In Marsh B, created by the pumping in of seawater, intertidal gammarids disappeared and chironomid larvae dominated as freshwater gradually replaced the seawater. In the Lagoon, connected to the sea by ducts, a large biomass and high species diversity were noted, but large, intertidal animals were scarce. A comparison with the results of surveys made on the tidal flat at the results of surveys made on the tidal flat at the mouth of Onosato River suggests that natural features should be introduced into Wild Bird Park for future development of an intertidal community. (Author's abstract)

FLOW CONTROL TECHNOLOGY FOR EN-HANCEMENT AND DIVERSE USE OF THE MARINE ENVIRONMENT.

Government Industrial Research Inst., Chugoku, Kure (Japan).

H. Ueshima, H. Tanabe, M. Takarada, I. Yuasa, and E. Hashimoto.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 743-746, 1991. 10 fig.

Descriptors: \*Anoxic conditions, \*Dikes, \*Flood Descriptors: "Anoxic conductions, "Dikes, "Friodic control, "Hydraulic models, "Japan, "Model stud-ies, "Water circulation, Algal blooms, Coastal waters, Osaka Bay, Red tide, Seto Inland Sea, Stagnant water, Tidal basins, Water exchange, Water movement

In the Seto Inland Sea, large red tide blooms and water mass anoxia exist, due to water stagnancy. Improvement of water mass movements may be made possible in a tidal basin through topography made possible in a tidal basin through topography change and construction efforts. The development of flow control technology is required to repair deteriorated water quality environments and to create appropriate physical flow fields which maximize the diverse use of coastal waters. Studies were carried out with the Seto Inland Sea hydrau-

#### Estuaries-Group 2L

lic model containing the Osaka and Beppu Bays. The effects of topography changes at the mouth of the bay and on the sea floor for Osaka Bay and a dike construction at the mouth of Beppu Bay were surveyed for water mass exchanges, circulation, and mixing and advection of the river water discharged into those how. charged into these bays. These measures effectively alter the balance and pattern of circulation, helping to improve water movement in the stagnant regions of the basin. (Author's abstract) W91-10607

IMPROVED POLICY INSTRUMENTS FOR MANAGEMENT OF ENCLOSED COASTAL SEAS AND ESTUARIES: THE CHESAPEAKE

SEAS AIM ESTABLES

BAY, USA.

Maryland Univ., Solomons. Center for Environmental and Estuarine Studies.

J. H. Cumberland.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 773-777, 1991. 1 tab.

Descriptors: \*Chesapeake Bay, \*Coastal waters, \*Coastal zone management, \*Economic aspects, \*Environmental policy, \*Estuaries, Environmental effects, Land use, Nonstructural alternatives, Policy making, Public participation, Public policy, Regulations, Resource allocation, Taxes, Water pollution control, Water quality standards.

The most coherent and systematic critique of current environmental policy instruments has come from economics, which has provided detailed tech-nical recommendations for policies utilizing eco-nomic incentives to pursue efficiency objectives. The major focus of environmental economics has been the design of ever more refined policy instru-ments for the efficient reduction of pollution exter-nalities. In many cases, economic incentives, such names. In many cases, economic incentives, such as pollution taxes, or an equivalent set of transferable, marketable emission permits can provide economic methods for improving water quality, usually at lower total social costs than can traditional regulatory methods. Pollution emitters usually sefer the equipment of the provider of prefer the regulatory system, because costs to them are much less than in incentive systems. Zoning can be an efficient means of controlling land use, but suffers some disadvantages from a public but suffers some disadvantages from a puone choice point of view. Compensating owners for land takings may lead to more efficient resource allocations. Marginal cost pricing on waterfront development could provide more accurate signals about the full social costs of waterfront development and provide incentives for reducing popula tion density in sensitive areas. Economic and posi-tive externalities would often be greater and environmental losses and negative externalities smaller if industrial and commercial development were if industrial and commercial development were shifted to inland areas, protecting sensitive water-front areas for recreational and low-density uses. Present management policies cannot save marine resources from immutable laws of thermodynamics and entropy, but environmental economics strengthened by insights from physical sciences, biological sciences, and from the study of public choice can assist in the search for more effective management policies. (Purpose-PTT) management policies. (Brunone-PTT) W91-10610

LEGAL SYSTEM AND MANAGEMENT OF SOUTHERN FRANCE LAGOONS.

Toulouse-1 Univ. (France).
For primary bibliographic entry see Field 5G.
W91-10611

ENUMERATION OF MOTILE AEROMONAS IN VALENCIA COASTAL WATERS BY MEM-BRANE FILTRATION.

Universida Politecnica de Valencia (Spain). Inst. of Hydrology and Environment. For primary bibliographic entry see Field 5B. W91-10636

MINIATURIZED FLUOROGENIC ASSAYS FOR ENUMERATION OF E. COLI AND EN-TEROCOCCI IN MARINE WATER. Institut Pasteur de Lille, Villeneuve d'Ascq

For primary bibliographic entry see Field 5A.

W91-10639

MOST PROBABLE NUMBER METHOD FOR THE ENUMERATION OF LEGIONELLA BAC-TERIA IN WATER.

Council for Scientific and Industrial Research, Pre-toria (South Africa). Div. of Water Technology. For primary bibliographic entry see Field 5A. W91-10640

BIOTECHNOLOGY DEGRADATION AND MITIGATION OF OFFSHORE OIL SPILLS, PHASE I. MAIN REPORT: TECHNOLOGY TO ENHANCE BIODECRADATION OF OIL SPILLS STATE OF THE ART AND PERSPEC-TIVES FOR TECHNOLOGY DEVELOPMENT. Norsk Petroleumsinstitut, Oslo.
For primary bibliographic entry see Field 5G.
W91-10735

ENVIRONMENTAL FEASIBILITY OF USING WETLANDS TO TREAT RUNOFF POLLU-

Naval Ocean Systems Center, San Diego, CA. For primary bibliographic entry see Field 5D. W91-10737

CORRELATED OCEANIC AND CONTINENTAL RECORDS DEMONSTRATE PAST CLIMATE AND HYDROLOGY OF NORTH AFRICA (0-140 KA).
Centre National de la Recherche Scientifique, Marseille (France). Lab. de Geologie du Quaternatic

For primary bibliographic entry see Field 2B.

ORGANIC CARBON ACCUMULATION IN BAFFIN BAY AND PALEOENVIRONMENT IN HIGH NORTHERN LATITUDES DURING THE

rast 20 M, Y. Giessen Univ. (Germany, F.R.). Inst. fuer Geowis-senschaften und Lithospharenforschung. For primary bibliographic entry see Field 2J. W91-10791

ECOTOXICOLOGICAL EFFECTS ASSESS-MENT: A COMPARISON OF SEVERAL EX-TRAPOLATION PROCEDURES. Rijksinstitut voor de Volksgezondheid en Milieu-hygiene, Bilthoven (Netherlands). For primary bibliographic entry see Field 5A.

W91-10830

SEASONAL VARIATIONS OF ALIPHATIC HY-DROCARBONS IN SARDINA PILCHARDUS (WALB.) (TELEOSTEI: CLUPEIDAE) TISSUES. Bologna Univ. (Italy). Ist. di Biochimica. For primary bibliographic entry see Field 5B. W91-10839

STUDIES OF DISSOLVED CARBOHYDRATES (OR CARBOHYDRATE-LIKE SUBSTANCES) IN AN ESTUARINE ENVIRONMENT.

IN AN ESTUARINE ENVIRONMENT.
Universite de Bretagne-Occidentale, Brest (France). Lab. d'Oceanographie Chimique.
W. Senior, and L. Chevolot.
Marine Chemistry MRCHBD, Vol. 32, No. 1, p 19-35, January 1991. 5 fig. 2 tab, 39 ref.

Descriptors: \*Analytical methods, \*Carbohydrates, \*Dissolved organic carbon, \*Estuarine environment, \*Seasonal variation, Bay of Brest, Elorn estuary, France, Organic matter, Salinity.

Variations in concentrations of dissolved sugars variations in concentrations of dissolved sugars were studied along the salinity gradient of a small estuary (Elorn, Bay of Brest, France) from February 1985 to January 1986. Total dissolved carbohyary 1983 to January 1986. Total dissolved carbony-drates (TDCHO) and dissolved monosaccharides (MCHO) were measured by methods that cannot distinguish between carbohydrates and carbohydrate-like substances; consequently, these methods probably do not closely reflect biologically available pools of carbohydrates. In the river, TDCHO

and MCHO values ranged from 230 to 970 micrograms C/l and from 75 to 450 micrograms C/l respectively. In the estuary, TDCHO and MCHO respectively. In the estuary, TDCHO and MCHO
were usually lower; they varied respectively from
20 to 570 micrograms C/1 and from 0 to 180
microgram C/1. In June, some TDCHO values
were much higher, probably because some polysaccharide was produced at this time by phytoplankton excretion or lysis. The relationship between Cl concentration and TDCHO was dependent on the seasons. TDCHO was conservative in
whater and early reprise TDCHO and autumn, winter and early spring. TDCHO and DOC concentrations were fairly well correlated during the same period. Similar results were previ-ously reported. MCHO and TDCHO concentrations were well correlated throughout this study except in June. It was concluded that most dised carbohydrates were linked to a conservative fraction of the organic matter in periods of low biological activity, whereas newly biosynthe-sized carbohydrates were responsible for non-con-servative behavior. (Author's abstract) W91-10840

FLUXES AND TRANSPORT OF ANTHROPO-GENIC AND NATURAL POLYCYCLIC AROMATIC HYDROCARBONS IN THE WESTERN MEDITERRANEAN SEA

Paris-6 Univ. (France). Lab. de Physique et Chimie

For primary bibliographic entry see Field 5B. W91-10841

TRACE METAL INTERACTIONS WITH MARINE PHYTOPLANKTON.

National Marine Fisheries Service, Beaufort, NC. Beaufort Lab. W. G. Sunda.

Biological Oceanography BOJODV, Vol. 6, No. 5/6, p 441-442, 1988/9. 10 fig, 3 tab, 92 ref.

Descriptors: \*Algal physiology, \*Nutrients, \*Phytoplankton, \*Toxicity, \*Trace metals, \*Water pollution effects, Chelation, Cobalt, Copper, Iron, Manganese, Metabolism, Nickel, Productivity,

Large spatial and temporal differences in both trace metal concentrations and chemical speciation in the sea have led to wide variations in biological availability of metals and their effects on phyto-plankton. Trace metals are usually taken up by algae via the formation of coordination complexes with specialized transport ligands in their outer membranes, and metal uptake is determined by the interplay between redox, complexation, or oxide interplay between redox, complexation, or oxide dissolution reactions of metals in seawater and ligand-exchange reactions at these sites. Some metals, such as Cu and Zn, are heavily chelated by organic ligands in seawater, and their biological availability is determined by the concentration of free metal ions or of kinetically labile inorganic species (free ions plus inorganic complexes). Once inside cells, trace metals influence metabolism primarily as a consequence of the role of many of these metals (Fe, Mn, Cu, Co, Mo, Ni) as essential cofactors in metallocarymes. Trace metals also inhibit metabolism when they bind to the wrong metabolic sites including those normally occupied by other essential nutrient metal ions. The interactions of metals at the biomolecular level determine their overall effect on cellular rate processes, such their overall effect on cellular rate processes, such as growth, and on the productivity of the phytoplankton community as a whole. Evidence exists for limitation of algal productivity by soluble inorganic Fe concentrations and Mn:cupric ion ratios in certain regions of the sea. However, wide differ-ences exist among algal species in their require-ments for nutrient metals or in their sensitivity to toxic metals, and thus the predominant effect of trace metals may be on species composition of phytoplankton communities. The effects of metals on phytoplankton are reciprocal, and the phytoplankton community itself has a profound influ-ence on the concentrations and chemical speciation of trace metals in seawater, providing important biological feedback. (Author's abstract) W91-10853

40, Winter 1991. 2 fig, 3 tab, 18 ref.

#### **Group 2L—Estuaries**

WETLAND IMPOUNDMENTS OF EAST-CEN-TRAL FLORIDA

Florida Medical Entomology Lab., Vero Beach. J. R. Rey, T. Kain, and R. Stahl. Florida Scientist FLSCAQ, Vol. 54, No. 1, p 33-

Descriptors: \*Coastal environment, \*Florida, \*Mangrove swamps, \*Salt marshes, \*Wetland impoundments, \*Wetlands, Flooding, Insect control, Resources management, Waterfowl, Wildlife man-

Data on the physical characteristics, vegetation, geographic location, and areal coverage of the astal impoundments in east-central Florida were llected. There are 195 impoundments in the collected. collected. There are 195 impoundments in the region, covering over 16,000 ha of coastal wetlands. Vegetation in the impoundments is diverse; mangroves predominate in the southern impoundments while herbaceous halophytes predominate in the northern ones. Approximately 3,600 ha of these impoundments are unvegetated, whereas mangroves cover close to 4,000 ha and other halophytic species 4,300 ha. Management of the impoundments varies from none to complex schemes that address not only mosquito control problems but also natural resource and habitat quality interests. Nearly 4,500 ha of impounded wetlands in the Merritt Island National Wildlife Refuge are flood-Merritt Island National Wildlife Reruge are Hood-ed year-round for waterfowl management, whereas 2,857 ha are under Rotational Impoundment Man-agement. Improved management of the east central Florida impoundments will continue to be a high priority item for local scientists, resource managers, environmental regulatory agencies, and mos-quito control personnel. Although there will conquito control personnel. Although there will con-tinue to be a strong push for enhancing lagoon-impoundment connections, particularly in im-poundments that are totally isolated, the emphasis is now shifting from managing individual impound-ments to managing groups of impoundments as blocks so that complementary management strate-gies can be applied to different members of the block. (Author's abstract) W91-10854

ANNUAL BACTERIAL PRODUCTION IN RE-ANNUAL BACTERIAL PRODUCTION IN RE-LATION TO BENTHIC MICROALGAL PRO-DUCTION AND SEDIMENT OXYGEN UPTAKE IN AN INTERTIDAL SANDFLAT AND AN INTERTIDAL MUDFLAT. Bigelow Lab. for Ocean Sciences, West Boothbay

L. M. Cammen L. m. - Caumien.
Marine Ecology Progress Series MESEDT, Vol.
71, No. 1, p. 13-25, March 28, 1991. 10 fig. 1 tab, 50 ref. NSF grants EXPO80-11448, OCE-83-09406, and OCE-83-11281.

Descriptors: \*Algae, \*Bacterial productivity, \*Intertidal areas, \*Marine bacteria, \*Marine sediments, \*Mud flats, \*Sand flats, Benthic fauna, Organic matter, Oxygen uptake, Seasonal variation, Water temperature.

In order to investigate the controls of bacterial abundance and production in marine sediments, bacterial production determined by uptake of 3-Hbacterial production determined by uptake of 3-Hthymidine, microalgal production and sediment oxygen uptake was investigated monthly for 1 yr in two benthic systems, an intertidal mudflat and an intertidal sandflat. There was a closer coupling between these rates in the sandflat than in the mudflat that may have been due to the more dynamic nature of the sandflat. The parameters measured fell into two groups based on the similarity between their annual totals or mean abundances for the mudflat and for the sandflat. Although ior the mutitat and for the sanditat. Although microalgal biomass, gross production, and sediment oxygen uptake were similar for both areas, bacterial biomass, bacterial production, and sediment organic carbon were all 4-5 times higher in the mudflat than in the sandflat. Estimated annual turnovers of the bacterial population were 52 for the postulation. the sandflat and 59 for the mudflat. Temperature the sandlat and 59 for the mudlat. Temperature was the factor that had the greatest influence on bacterial production, explaining 55-57% of seasonal variation in specific growth rate. Bacteria appeared to respond to the increase in temperature in late winter-early spring more quickly than the rest of the sediment community; this would imply that

the input of organic matter to the benthos from an early spring bloom, occurring in colder waters, might result in a less efficient transfer of energy to the macrofauna, than would occur with a later the macrofauna than would occur with a bloom. (Author's abstract) W91-10865

ASSIMILATION OF METALS IN MARINE CO-PEPODS AND ITS BIOGEOCHEMICAL IM-PLICATIONS.

State Univ. of New York at Stony Brook. Marine

Sciences Research Center.

N. S. Fisher, C. V. Nolan, and S. W. Fowler.

Marine Ecology Progress Series MESEDT, Vol.

71, No. 1, p 37-43, March 28, 1991. 3 fig, 1 tab, 43 ref. NSF grant OCE 8810657.

Descriptors: \*Bioaccumulation, \*Biogeochemistry, \*Copepods, \*Geochemical cycles, \*Marine biology, \*Metals, \*Path of pollutants, Americium, Cadmium, Feces, Marine algae, Marine environment, Mercury, Plutonium, Radioisotopes, Zinc.

Laboratory experiments employing gamma-emit-ting radiotracers assessed the retention efficiency of ingested metals in the calanoid copepod Anoma-locera patersoni and the retention of excreted metals in fecal pellets. Adult copepods ingested the haptophyte Isochrysis galbana labeled with 109-Cd, 65-Zn, 203-Hg, 241-Am and 237-Pu at a rate of 3.79 mg algal C/g animal dry wt/h. Average re-tention efficiencies were 30% for Cd, 48% for Zn, 21% for He, 4.5% for Am, and 0.8% for Ph. Adv. 21% for Hg, 4.5% for Am, and 0.8% for Pu. Algal cells resuspended into unlabeled seawater retained cens resuspended into unaocied seawater retained metals to varying extent, with depuration curves conforming to a 2-compartment model; Cd was lost most rapidly. The fecal pellets produced by animals feeding on radioactive I. galbana lost essentially all of their 109-Cd, 65-Zn, 241-Am, and 237-Pu to unlabeled seawater within 1 d. 203-Hg was lost most slowly, again conforming to a 2 compartment model; its retention half-time was compartment model; its retention half-time was about 25 d in the slowly exchanging pool. Bacterial activity did not appear to have an effect on metal retention in the fecal pellet. The retention efficiencies suggest that Cd, Zn, and Hg should be recycled by copepods in surface waters as part of the organic cycle in the sea, while the transuranic elements should be defecated and removed from surface waters by sinking biogenic debris. (Ausurface waters by sinking biogenic debris. (Author's abstract) W91-10866

BALANCE OF NUTRIENT LOSSES AND GAINS IN SEAGRASS MEADOWS. Delta Inst. for Hydrobiological Research, Yerseke

M. A. Hemminga, P. G. Harrison, and F. Van

Marine Ecology Progress Series MESEDT, Vol. 71, No. 1, p 85-96, March 28, 1991. 1 fig, 3 tab, 106

Descriptors: \*Cycling nutrients, \*Marine sediments, \*Sea grasses, \*Wetlands, Biomass production, Denitrification, Diffusion, Foraging, Leaves, Marine environment, Nitrogen fixation, Sedimenta-

Seagrasses abound in the dynamic environment of shallow waters. From the often high annual bio-mass production it can be deduced that seagrass meadows have high requirements for inorganic nutrients, although the nutrient demands will be met to some extent by internal recycling. A series of processes lead to nutrient losses from the sea-grass bed. Export of leaves and leaf fragments with currents, leaching losses from photosynthetically active leaves and from senescent and dead plant material, and nutrient transfer by mobile foraging animals, are processes specific to seagrass mead-ows. In addition, the nutrient losses are aggravated by 2 processes commonly occurring in marine sediments: denitrification and diffusion of nutrients The persistence in time of most seagrass meadows points to an existing balance between nutrient losses and gains. Three processes losses and gains. Three processes may contribute to the replenishment of nutrients: nitrogen fixation, sedimentation and nutrient uptake by the leaves. Nitrogen fixation undoubtedly is important, but

continued biomass production requires other nutrients as well. Crucial contributions, therefore, must come from sedimentation and/or leaf uptake. The concept of the seagrass meadow as an open system, with nutrient fluxes from and to the system varying in time, allows for imbalances between nutrie losses and gains. It is suggested that these imbal-ances may contribute to fluctuations in annual seagrass biomass production. (Author's abstract) W91-10867

COULOMETRIC MEASUREMENT OF PRI-MARY PRODUCTION, WITH COMPARISON AGAINST DISSOLVED OXYGEN AND 14-C METHODS IN A SEASONAL STUDY.

Bedford Inst. of Oceanography, Dartmouth (Nova Scotia). Biological Oceanography Div.

Marine Ecology Progress Series MESEDT, Vol. 71, No. 1, p 97-102, March 28, 1991. 4 fig, 1 tab, 19

Descriptors: \*Coulometry, \*Nova Scotia, \*Photo-synthesis, \*Phytoplankton, \*Primary productivity, Analytical methods, Carbon dioxide, Carbon radioisotopes, Dissolved oxygen, Marine environ-

Consumption of CO2, as measured by direct coulometry in light and dark bottles, was used to estimate the photosynthetic rate of natural assemblages of phytoplankton incubated in situ. A total of 30 experiments were made during a 12-month period in Bedford Basin, Nova Scotia. For comparison, simultaneous estimates of primary produc-tion were made on each occasion using both the light-and-dark-bottle oxygen method and the 14-C method. Primary production values fell in the range <1 to 50 mmol/cu m/d. Throughout this range, excellent agreement was found between primary production as estimated by the 14-C meth and gross primary production estimated by changes in dissolved CO2. Release of labelled carbon into solution accounted for 2-19% of total primary production as measured by the 14-C method, with the lower values occurring in the spring bloom period. When the carbon-based rewere compared with the oxygen-based ones, they agreed to within a mean apparent photosynthetic quotient (PQ) of 1.6. High apparent PQ's in winter are attributed to an overestimation of oxygen primary production and an underestimation of 14-C primary production. Direct coulometry offers considerable promise as a technique for measuring photosynthesis by phytoplankton. (Author's abstract)

IMPACT OF TITANIUM DIOXIDE WASTE ON FERTILIZATION IN THE SEA URCHIN ECHINOMETRA MATHAEI.

Council for Scientific and Industrial Research, Congella (South Africa). Estuaries and Freshwater Pollution

For primary bibliographic entry see Field 5C. W91-10870

BEHAVIOR OF HEAVY METALS IN A MUD FLAT OF THE SCHELDT ESTUARY, BEL-

Vrije Univ., Brussels (Belgium). Dienst Analytische Scheikunde en Geochemie. For primary bibliographic entry see Field 5B. W91-10872

EFFECT OF THREE PRIMARY TREATMENT SEWAGE OUTFALLS ON METAL CONCENTRATIONS IN THE FISH CHEILODACTYLUS FUSCUS COLLECTED ALONG THE COAST OF SYDNEY, AUSTRALIA.

Metropolitan Water, Sewerage and Drainage Board, Sydney (Australia). For primary bibliographic entry see Field 5B.

# Estuaries—Group 2L

COEFFICIENT OF POLLUTION (P): THE SOUTHERN CALIFORNIA SHELF AND SOME OCEAN OUTFALLS.

California State Univ., Long Beach. Dept. of Biol-

ogy. For primary bibliographic entry see Field 5B. W91-10874

VISUAL INTERPRETATION OF A LANDSAT MOSAIC OF THE OKAVANGO DELTA AND SURROUNDING AREA.

School of Agriculture, University of Bophuthats-wana, South Africa.

For primary bibliographic entry see Field 2H. W91-10879

CHEMICAL COMPOSITION OF THE INTER-STITIAL WATER IN BOTTOM SEDIMENTS OF TYRRHENIAN SEA (WESTERN MEDITER-RANEAN): DIAGENETIC PROCESSES.

Alexandria Univ. (Egypt). Inst. of Graduate Studies and Research. For primary bibliographic entry see Field 2J. W91-10880

MERCURY BODY BURDEN AND OTOLITH CHARACTERISTICS OF BLUEFIN TUNA FROM THE NORTHWEST MEDITERRANEAN (BALEARIC SEA).

(BALEARIC SEA), Universitat de les Illes Balears, Palma de Mallorca (Spain). Inst. d'Estudis Avancats. B. Morales-Nin, and J. M. Fortuno. Scientia Marina, Vol. 54, No. 3, p 277-285, September 1990. 13 fig, 3 tab, 25 ref.

Descriptors: \*Bioaccumulation, \*Fish physiology, \*Fish populations, \*Mediterranean Sea, \*Mercury, \*Path of pollutants, \*Population dynamics, \*Tuna, Aluminum, Balearic Sea, Calcium, Chlorides, Fish migration, Growth stages, Otoliths, Silicon, Sodium, Spawning, Strontium, Sulfur, Tissue anal-

The Hg burden and otolith characteristics of bluefin tuna caught in the Balearic Sea, northwest Mediterranean were studied in order to determine Mediterranean were studied in order to determine their population dynamics and gather additional information for the delineation of bluefin populations. The tissue Hg levels ranged widely. In juveniles the levels were high and significant, showing the dependence of Hg level on fish size. The amount of Hg increased notably in older fish but was poorly correlated to body weight. The otolith microstructure was vary variable, which only allowed the differentiation of growth phases from juvenile to adult. The microincrement width was very variable and probably a function of the time of year when it was deposited. Observations of increment width suggests that wide increments were deposited during favorable conditions, while thin increments corresponded to unfavorable periods (migrations, spawning, winter). The marginal thin increments corresponded to uniavoue periods (migrations, spawning, winter). The marginal otolith structures of giant fish show that the majority (55%) were actively growing during their migration. The formation of discontinuous structures in the otoliths might be related to the physiological status, spawning and migration. The otoliths corresponding to a lower Hg burden were characterized by a more uniform elemental composition (Na, Cl, Ca, Sr, Si, S, Al), while the high Hg burden fish showed more variability in their composition. The otolith elemental composition might reflect ambiotolin elemental composition might relect anoisent water, dietary differences or water temperature differences. This might suggest a more changing environment experienced by the high Hg body burden fish. These results are a first attempt to differentiate the two postulated tuna populations in the Mediterranean. (Sand-PTT)
W91-10881

SECONDARY SALINIZATION OF SOILS OF THE DNIESTER DELTA FLOODPLAIN. Kiev State Univ. (USSR). Dept. of Geography. For primary bibliographic entry see Field 2G. W91-10917

REMOBILIZATION OF CU FROM MARINE PARTICULATE ORGANIC MATTER AND FROM SEWAGE,

National Oceanic and Atmospheric Administra-tion, Seattle, WA. Pacific Marine Environmental Lab.

For primary bibliographic entry see Field 5B. W91-10923

VOLTAMMETRIC DETERMINATION OF THE COMPLEXATION PARAMETERS OF ZINC IN MARINE AND ESTUARINE WATERS, Rhode Island Univ., Kingston. Graduate School of

Oceanography.
For primary bibliographic entry see Field 2K.
W91-10924

DISTRIBUTION OF DISSOLVED CADMIUM, LEAD AND COPPER IN THE BRISTOL CHAN-NEL AND THE OUTER SEVERN ESTUARY. Ministry of Agriculture, Fisheries and Food, Burnham on Crouch (England). Fisheries Lab. For primary bibliographic entry see Field 5B. W91-10925

MEASUREMENT OF THE DIFFERENT FORMS OF ZINC IN NARRAGANSETT BAY WATER BASED ON THE RATE OF UPTAKE BY A CHELATING RESIN.
Rhode Island Univ., Kingston. Graduate School of

Oceanography.
For primary bibliographic entry see Field 2K.
W91-10926

ENGINEERING GEOLOGY OF NEARSHORE AREAS OFF RICHARDS ISLAND, N.W.T.: A COMPARISON OF STABLE AND ACTIVELY ERODING COASTLINES.

Geological Survey of Canada, Ottawa (Ontario). For primary bibliographic entry see Field 2J. W91-10944

OIL TRANSPORT MANAGEMENT AND MARINE POLLUTION CONTROL: OIL SPILL PREVENTION.

Rutgers - The State Univ., Piscataway, NJ. For primary bibliographic entry see Field 5G. W91-11081

SULFUR ENRICHMENT OF HUMIC SUB-STANCES IN A DELAWARE SALT MARSH SEDIMENT CORE. Delaware Univ., Newark. Coll. of Marine Studies. T. G. Ferdelman, T. M. Church, and G. W.

Geochimica et Cosmochimica Acta GCACAK, Vol. 55, No. 4, p. 979-988, April 1991. 7 fig. 5 tab, 49 ref. NSF grants OCE-8541757, OCE-8696121, and OCE-8916804.

Descriptors: \*Humic substances, \*Marine sediments, \*Organic matter, \*Salt marshes, \*Sulfur, Detritus, Pyrite, Spartina, Sulfur compounds.

equential extraction scheme, results, and pos-The sequential extraction scheme, results, and possible implications regarding the formation and distribution of solid-phase organic sulfur in salt marsh sediment is reported. Samples from 9 depths of the core of a Delaware Spartina alterniflora marsh sediment were sequentially extracted in a glovebox or glovebag under nitrogen atmosphere and in subdued light. Humic sulfur, operationally defined as the sulfur extracted with humic substances in 0.1 N NaOH solution, comprised up to 51% of the total sulfur inventory in the core. Pyrite sulfur was the next largest fraction, except at the near-surface sediments, where zerovalent sulfur concentrations were significant. X-ray photoelectron spectrosco-py indicated that the humic sulfur consists of sul-foxides or sulfones and, in a more reduced state, organic sulfides and/or organic polysulfides. A subsurface decrease in the humic acid C:S atomic ratio to 56 + or -2 suggests that the upper 4 cm of marsh sediment is the locus for humic sulfur formation. S. alterniflora detritus and microbial biomass cannot fully account for observed sulfur enrichment of humic C:S atomic ratios. The enrichment of humic substances by sulfur is probably via reaction of reduced sulfur compounds with organic matter. A humic sulfur formation rate of 10.6 mi-

cromoles S/cu cm/a is calculated for the surfa sediments and leads to an areal production of 18 micromoles S/sq cm/a of humic sulfur. Humic sulfur formation and preservation is enhanced by the limited availability of iron for the rapid precipi-tation of iron sulfide minerals and the apparent resistance of organic sulfur compounds towards reoxidation to sulfate, especially in the upper 9 cm of marsh sediment where inorganic sulfur compounds are rapidly oxidized. (Author's abstract) pounds are W91-11258

BRINE-INDUCED ADVECTION OF DIS-SOLVED AROMATIC HYDROCARBONS TO ARCTIC BOTTOM WATERS.

Science Applications International Corp., San Diego, CA. For primary bibliographic entry see Field 5B. W91-11340

MICROBIAL MATS IN TIDAL CHANNELS AT SAN CARLOS, BAJA CALIFORNIA SUR, MEXICO.

Centro de Investigaciones Biologicas de Baja Cali-fornia Sur, La Paz (Mexico). Dept. of Microbiolo-

gy.
A. Lopez-Cortes. Geomicrobiology Journal GEJODG, Vol. 8, No. 2, p 69-85, April/June 1991. 10 fig, 1 tab, 16 ref.

Descriptors: \*Aquatic bacteria, \*Cyanophyta, \*Estuaries, \*Estuaries, \*Estuarine environment, \*Microbial mats, \*Species composition, Diatoms, Estuarine sediments, Mexico, Overflow channels, Sedimentary

rocks, Tidal flats.

Microbial mats are ancient biological phenomena which have been documented in fossil records as laminated sedimentary rocks of domal, columnal, minimated sedimentary rocks of domal, columnal, or other geometrical structures collectively termed stromatolites. The macroscopic and microscopic characteristics of mats and their annual growth were studied in microbial communities of stratified phototrophic bacteria in laminated intertical sediments could be seen to ments north of Estuary El Punte, near San Carlos, Baja California Sur, Mexico. The mats were locat-Baja California Sur, Mexico. The mats were location and along meandering mangrove-lined tidal channels. Their thickness ranged from 0.5 to 25 cm. Square-meter areas of polygonal mats were found in several ponds infiltrated by sea water. The principal microbial community of the upper surface of the various microbial mat morphotypes was identified as cyanobacteria of the general Micrococleus, Lyngbya, Phormidium, and Oscillatoria. Other less prominent cyanobacteria were Pseudan. crocious, Lyngoya, Phormidium, and Oscillatoria.
Other less prominent cyanobacteria were Pseudanabaena, Spirulina, Synechococcus, and Gloeocapsa. There were also many unidentified diatoms at lower densities. The second inward reddish layers of microbial mats contained similar cyanobacterial genera plus anoxygenic phototrophic bac-teria identified as Chloroflexus, Thiocapsa, Chromatium, Prosthecochloris, Rhodopseudomonas, and Chlorobium and several unidentified bacteria. and chorosoum and several undentured outcern.

In-situ measurements on the growth of the mats, from intermittent tide sites, showed an annual buildup of two layers: green and reddish. These layers correspond to a vertical growth of 1.4 plus or minus 0.27 mm/yr. Permanently submerged or mmus U.21 mm/yr. Permanently submerged mats did not show vertical growth during the same observation period. Information obtained from these mats may be useful in the climatic reconstruction of Baja California Sur and to elucidate the forms of preserved fossil stromatolites. (Medina-PTT) W91-11400

ROTIFERS OF THE GENUS SYNCHAETA-AN IMPORTANT COMPONENT OF THE ZOO-PLANKTON IN THE COASTAL WATERS OF THE SOUTHERN BALTIC.

HE SOUTHERN BALTIC.
Akademie der Wissenschaften der DDR, Berlin.
Inst. fuer Geographie und Geooekologie.
H. Arndt, C. Schroder, and W. Schnese.
Limnologica LMNOA8, Vol. 21, No. 1, p 233-235,
October 1990. 2 fig. 1 tab, 21 ref.

Descriptors: \*Baltic Sea, \*Coastal waters, \*Physiological ecology, \*Rotifers, \*Synchaeta, \*Zooplankton, Algae, Bacteria, Biomass, Cyanophyta, Flagel-

# **Group 2L—Estuaries**

lates, Food chains, Food habits, Growth rates, Physical properties, Protozoa, Salinity, Seasonal variation, Water temperature.

At least 16 species of the rotifer Synchaeta were found in the coustal waters between Hiddensee Island and the Darss-Zingst peninsula (Germany). Species of Synchaeta are able to ingest particles ranging in size from bacteria to rotifers, including Cyanophyta, algae, flagellates, and ciliates. Species such as S. fittoralis, S. oblongata, and S. lakowitziana prefer cooler waters (<15 C), while S. cecilia, S. t. kitina, and S. triophthalma are found in warmer waters (>15 C); S. vorax seems to be euthermal. Some of the marine Synchaeta species were found at salinities down to 3 ppt, while some tolerated salinities up to 5 ppt. Analysis of field data revealed growth r-values for S. cecilia (Sept./Oct. 1983, 14 C) and S. vorax (Feb./Mar. 1984, 2-3 C) of 0.11 and 0.01/d, respectively. Routine sampling revealed that the highest abundance of Synchaeta spp. occurred in early spring and autumn. In early spring, Synchaeta account for most of the metazooplankton biomass (>60%) and are able to consume a significant fraction of the spring peak of phytozooplankton and protozooplankton production. Their use as a food source by higher trophic levels seems to be of minor importance. (Doria-PTT)

HYDROBIOLOGICAL SURVEY OF THE CHANOMI CREEK SYSTEM, LOWER NIGER DELTA. NIGERIA.

Port Harcourt Univ. (Nigeria). Dept. of Zoology. For primary bibliographic entry see Field 5C. W91-11524

ANALYSIS AND INTERPRETATION OF THE BOREHOLE TELEVIEWER LOG: INFORMATION ON THE STATE OF STRESS AND THE LITHOSTRATIGRAPHY AT HOLE 504B.

Geological Survey, Denver, CO. For primary bibliographic entry see Field 7C. W91-11549

USE OF THE INTERTIDAL ZONE BY FISH IN NOVA SCOTIA.

Western Australia Univ., Nedlands. Dept. of Zoology.

R. Black, and R. J. Miller.

Environmental Biology of Fishes EBFID3, Vol. 31, No. 2, p 109-121, June 1991. 2 fig. 9 tab, 24 ref. Halifax Department of Fisheries and Oceans Contract No. 05080-00257.

Descriptors: \*Intertidal areas, \*Nova Scotia, \*Fish populations, Biological studies, Ecosystems, Seaweed, Cunner, Sculpin.

In Nova Scotia the annual harvest of the intertidal seaweed Ascophyllum nodosum exceeds 20,000 tons. This study investigated the possible impact of removal of the seaweed on intertidal abundance of fish in small areas and their gut contents. At sites near Lower Argyle, Nova Scotia, absolute abundance of fish in small areas with Ascophyllum removed and intact was determined with pop-up seines. Gut contents were investigated from fish collected with the seines and with trammel nets. Number and weight of fish were not significantly different between cleared and intact areas and averaged 4.6 individuals and 160 g/400 sq m during June to October. Cunner and sculpins had more food in their guts when leaving then when entering the intertidal, but only cunner had more food in their stus when leaving intact ares than when leading cleared areas. Most fish captured in the intertidal were small (< 15 cm) and of no commercial value, and the numbers of commercial species were too low to be of much value. Numbers of fish in the intertidal was significantly lower than in the shallow subtidal. This study provided no evidence for adverse effects of the removal of patches of Ascophyllum on fishes. (Author's abstract)

#### 3. WATER SUPPLY AUGMENTATION AND CONSERVATION

#### 3A. Saline Water Conversion

INVESTIGATIONS WITH ELECTRODIALYSIS REVERSAL FOR THE TREATMENT OF SURFACE WATER TO MAKE-UP WATER. Ulrechtseweg 310, 6812 AR, Arnhem, The Netherlands. For primary bibliographic entry see Field 5F. W91-11368

#### 3B. Water Yield Improvement

RESEARCH ON CLOUDS AND PRECIPITA-TION: PAST, PRESENT AND FUTURE, PART

Washington Univ., Seattle. Dept. of Atmospheric Sciences.

Bulletin of the American Meteorological Society BAMIAT, Vol. 72, No. 2, p 184-191, February 1991. 6 fig, 1 ref.

Descriptors: \*Acid rain, \*Climatic changes, \*Cloud seeding, \*Clouds, \*Global warming, \*Meteorology, \*Precipitation, Chemistry of precipitation, Cloud physics, Research, Weather.

Starting in the 1940s, an important spin-off from cloud physics research attempted to modify clouds and precipitation by artificial seeding. During the 1950s-1970s, many viewed clouds as something that could be readily milked to produce precipitation. The history of cloud seeding provides a subtory lesson on the need for sound basic research to precede attempts to operations. In the early 1980s, the importance of chemical reactions in clouds to acid deposition became more widely recognized, making cloud chemistry a discipline in its own right. Currently, thought turns increasingly to global change. Land, ocean, and clouds are seen as important players in global change, with the feedback effects of clouds being one of the major areas of uncertainty. Clouds are destined to remain near center stage in meteorological research. Their study will uncreasingly involve scientists with multifarious interests and backgrounds. Although large multidisciplinary programs will provide new opportunities to tackle some important problems, this approach is not necessarily the best way to tackle all of the outstanding problems in cloud research. (Mertz-PTT)

# 3C. Use Of Water Of Impaired Quality

ASSESSMENT OF THE SALINITY TOLER-ANCE OF EIGHT SONORAN DESERT RIPARI-AN TREES AND SHRUBS.

AN IREES AND STRUBS.

Nevada Univ. System, Reno. Desert Research Inst.

J. Jackson, J. T. Ball, and M. R. Rose.

Available from the National Technical Information
Service, Springfield, VA 22161 as PB91-129627.

Price codes: A06 in paper copy, A01 in microfiche.
September 10, 1990. 102p. 20 fig. 21 tab, 41 ref,
append. USBR Contract No. 9-CP-30-07170.

Descriptors: \*Environmental effects, \*Irrigation effects, \*Riparian vegetation, \*Salinity, \*Salinization, \*Sonoran Desert, Albedo, Chlorophyll, Photosynthesis, Plant morphology, Plant stress.

Eight species of Sonoran Desert riparian trees and shrubs were examined in a greenhouse-based study of salinity tolerance at six levels: 0, 1,500, 6,000; 18,000; 36,000; and 60,000 mg/L. Analysis of percent survival and morphological growth response indicated that two of the eight species, Populus fremontii and Salix gooddingii exhibited no tolerance above 1,500 mg/L. Tessaria sericea was intolerant of salinity levels of 18,000 mg/L and above. Atriplex lentiformis and Tamarix chinensis exhibit-

ed significant growth decreases at 36,000 and 60,000 mg/L. Prosopis juliflora var. torreyana, and P. pubescens growth responses were not readily detectable because growth under experimental conditions was slow. Indications of salt tolerance were observed in Allenrolfea occidentalis growth response, and the data suggested greater growth response at intermediate salinity levels. Laboratory measurement of spectral reflectance of leaves suggested that salt stress was discernable through examination of the location of the 'red edge' of the electromagnetic spectrum, and that measurement of reflectance may provide a predictor or indicator of salinity stress. Measurement of photosynthesis show that salinity clearly reduces the rate of carbon gain in all studied species. Technical problems will have to be overcome before measurement of photosynthesis will be a useful tool for detecting salinity damage in the field. Measurements of chlorophyll fluorescence indicate that under field conditions differences in this parameter are unlikely to appear in relation to salinity stress. (Author's abstract) W91-10752

REGIONAL APPROACH TO SALINITY MAN-AGEMENT IN RIVER BASINS, A CASE STUDY IN SOUTHERN IRAN.

Agricultural Univ., Wageningen (Netherlands). Dept. of Hydraulics and Catchment Hydrology. For primary bibliographic entry see Field 5G. W91-11432

EFFECT OF LOW SALINITY WATER ON SALT DISPLACEMENT IN TWO SOILS.

Cairo Univ., Giza (Egypt). Faculty of Agriculture. For primary bibliographic entry see Field 2G. W91-11433

PRODUCTION FUNCTIONS RELATING CROP YIELD, WATER QUALITY AND QUANTITY, SOIL SALINTIY AND DRAINAGE VOLUME. California Univ., Riverside. Dept. of Soil and Environmental Sciences.

A. Dinar, J. D. Rhoades, P. Nash, and B. L. Waggoner.

Agricultural Water Management AWMADF, Vol. 19, No. 1, p 51-66, January 1991. 5 fig, 7 tab, 18 ref.

Descriptors: \*California, \*Crop yield, \*Drainage water, \*Irrigation water, \*Lysimeters, \*Saline soils, \*Salinity, Decision making, Imperial Valley, Saline water, San Joaquin Valley.

Lysimeter data were used to estimate relationships between yield, water quantity and quality, soil salinity and drainage volumes for a variety of conditions similar to those prevailing in the San Joaquin and the Imperial Valleys of California. Coefficients for the various estimated functions were found to be statistically significant and in most cases were also in agreement with findings provided by previous studies. A major conclusion was that a direct relation between yield and average seasonal soil salinity does not apply to conditions where several limiting factors are interrelated. The results imply that the lysimeter-based functions can also be used to develop information needed for decision making. Lysimeter experiments are relatively easy to control and can be used to simulate a variety of environmental conditions. The lysimeter results can verify normative predictions of the models, and if necessary to calibrate for local conditions. Relationships for crops can be used to evaluate different alternatives of irrigation/drainage management on a field or farm level. (Author's abstract)

# 3D. Conservation In Domestic and Municipal Use

WATER USE REDUCTIONS FROM RETRO-FITTING INDOOR WATER FIXTURES. Brown and Caldwell, Pleasant Hill, CA. For primary bibliographic entry see Field 6D. W91-10811

#### WATER SUPPLY AUGMENTATION AND CONSERVATION—Field 3

#### Conservation In Agriculture—Group 3F

RESIDENTIAL WATER CONSERVATION:

Arizona Univ., Tucson. Office of Arid Lands Stud-

M. M. Karpiscak, K. E. Foster, and N. Schmidt. Water Resources Bulletin WARBAQ, Vol. 26, No. 6, p 939-948, December 1990. 8 fig, 2 tab, 16 ref.

Descriptors: \*Demonstration projects, \*Domestic water, \*Water conservation, \*Water reuse, \*Water schortage, \*Water use, Arid lands, Arizona, Evaporative cooler water use, Graywater reuse, Residential water conservation, Water costs, Water demand, Water harvesting, Water management, Water resources

The issue of water conservation has received the most attention in areas where the prospect of water shortages is most imminent. Arid areas with finite groundwater supplies and scarce surface water re-sources, such as the American Southwest, face sources, such as the American Southwest, face water supply problems now that will affect other areas later. In 1985, the University of Arizona designed and retrofitted Casa del Agua (CDA), a residential water conservation experimental and demonstration home in Tucson, Arizona. The single-family residence was retrofitted with water-conserving fixtures, rainwater harvesting, and graywater reuse systems. Detailed measurements of water use during the subsequent four years provide a useful database for evaluating the potential benefits of residential conservation techniques tial benefits of residential conservation techniques and technologies on overall water use. The results and technologies on overall water use. The results of the study revealed that the demand for domestic water was reduced significantly at the house without reducing the residents' quality of life. The use of municipal water was reduced by 66 percent to 148 gallons per day (gpd) and total household use was reduced by 27 percent to 245 gpd. Graywater reuse averaged approximately 77 gpd or 32 percent of the total household water use. Evaporative cooling required about 15 gpd. Water use for toilet flushing was only 9 gallons per capita per day (gpcd) or 14 percent of interior water use. Water savings not only help alleviate the demand for a or 14 percent of interior water use. Water savings not only help alleviate the demand for a diminishing resource, but also reduce both water and energy bills for households. (Korn-PTT)

#### 3F. Conservation In Agriculture

FACTA 1990 CONSERVATION AND ENVI-RONMENTAL HIGHLIGHTS. VEBA Oel Technologie G.m.b.H., Gelsenkirchen

(Germany, F.R.). For primary bibliographic entry see Field 5G. W91-10507

WATER CONTROL SYSTEMS AND THE TRA-DITIONAL FESTIVAL AT MIYAWAKI, ON THE SETO INLAND SEA.

National Inst. of Multimedia Education, Chiba

(rapan). T. Oohashi, and M. Kono. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 653-657, 1991. 7 fig, 4 ref.

Descriptors: \*Irrigation practices, \*Japan, \*Public participation, \*Seto Inland Sea, \*Water demand, \*Water resources management, Agriculture, Climates, Coastal areas

In Miyawaki, Japan, a village facing an enclosed coastal sea, little rain falls, due to the typical Seto coastal sea, little rain falls, due to the typical Seto Inland Sea climate. Therefore, the control of irrigation system facilities, indispensable for paddy field cultivation, has been a constant concern of the village. The basic social unit for water control and management is made up of small neighborhood units. Larger groups are formed by a number of these small units located close together and utilizing the same waterway. The close social structure that is enhanced by local festivals is an important aspect of water management strategies. A type of negative feedback-control occurs in the community when conflict arises concerning the irrigation negative teedoack-control occurs in the communi-ty when conflict arises concerning the irrigation system. Rather than risk disrupting the social struc-ture surrounding the festival, compromises are made in regard to water use. The traditional wisdom inherited in Miyawaki has been adapted to

solve problems encountered in modern society. (Brunone-PTT) W91-10591

MODEL OF AMMONIA VOLATILIZATION FROM APPLIED UREA. V. THE EFFECTS OF STEADY-STATE DRAINAGE AND EVAPORA-

Oxford Univ. (England). Soil Science Lab. G. J. D. Kirk, and P. H. Nye. Journal of Soil Science JSSCAH, Vol. 42, No. 1, p 103-113, March 1991. 5 fig, 1 tab, 17 ref.

Descriptors: \*Ammonia, \*Drainage effects, \*Evaporation, \*Fertilization, \*Model studies, \*Ureas, \*Volatilization, Alkalinity, Boundary conditions, Continuity equation, Dispersion, Drainage, Hydraulic properties, Irrigation, Mathematical studies, Rainfall, Soil water, Solute transport, Water

The effectiveness of urea, which is now the major nitrogen fertilizer in both temperate and tropical nitrogen retuizer in both temperate and tropical agriculture, is in many cases, severely limited by losses through ammonia volatilization. A mechanistic model has been developed that enables the prediction of ammonia volatilization and the distribution in soil of urea, ammoniacal nitrogen, and pH, following urea application. The model has been expanded to account for the effects of steadystate water movement by drainage or evaporation when the soil does not dry out to any great extent. The model was used to asses the effects on volatiliation of evaporating conditions and of irrigation or rainfall. Preliminary modeling results revealed how upward movement of water during evaporation increased velocities. now upward movement of water during evapora-tion increased volatilization by carrying urea-de-rived NH4(+) and HCO3(-) ions upward, thereby increasing the concentration of ammonia gas at the surface. Conversely, water drainage reduced vola-tilization by carrying the dissolved solutes into the soil. (Korn-PTT) (See also W91-10806)

MODEL OF AMMONIA VOLATILIZATION FROM APPLIED UREA. VI. THE EFFECTS OF TRANSIENT-STATE WATER EVAPORATION.

Oxford Univ. (England). Soil Science Lab. G. J. D. Kirk, and P. H. Nye. Journal of Soil Science JSSCAH, Vol. 42, No. 1, p 115-125, March 1991. 6 fig, 3 tab, 16 ref.

Descriptors: \*Ammonia, \*Evaporation, \*Fertilizers, \*Model studies, \*Ureas, \*Volatilization, Boundary conditions, Continuity equation, Convection, Diffusion, Finite difference methods, Hydraulic properties, Hydrogen ion concentration, Mathematical studies, Moisture profiles, Neutralization, Soil water, Solute transport, Temperature

A mechanistic model that predicts ammonia volatilization and the distribution in soil of urea has been expanded to account for the effects of tranbeen expanded to account for the effects of transient-state water evaporation when the soil surface dries significantly. Solute and water continuity equations were derived and solved using the finite difference method. For the wide range of soil hydraulic properties considered in the investigation, the effects of a dry soil layer on the rate of volatilization supplemented the effects of increased convective supply of NH4(+) and HCO3(-) ions to the soil surface. The dry layer resulted in increased gaseous NH3 diffusion through the soil, and thereby increased the flux of NH3 across the soil surface and the neutralization of H(+) ions generated by volatilization. (Korn-PTT) (See also W91-10805)

ADOPTION OF WATER-SAVINGS PRACTICES BY IRRIGATORS IN THE HIGH PLAINS. Kansas State Univ., Manhattan. Dept. of Geogra-

D. E. Kromm, and S. E. White. Water Resources Bulletin WARBAQ, Vol. 26, No. 6, p 999-1012, December 1990. 2 fig, 8 tab, 19 ref.

Descriptors: \*Agricultural water, \*Great Plains, \*Groundwater depletion, \*Irrigation, \*Irrigation

practices, \*Water conservation, Energy costs, High Plains, Irrigation efficiency, Legislation, Sur-veys, Water policy.

The High Plains has been viewed as an immense and regarden because of its highly productive agricultural system based on irrigation. Irrigated agricultural system based on irrigation. Irrigated agriculture in the High Plains aquifer region peaked about 1980, when over 17.8 million acre feet of water were pumped to irrigate approximately 14 million acres of farmland. Rising energy costs and ground-water depletion resulted in a 20 percent decline in irrigated acreage harvested between 1978 and 1987. There is a growing concern that the region may be returning to its natural state of a vast shortgrass prairie. Efforts to avoid this scenario and to ensure continued survival of the integrated and to ensure communes survival or the integrated agribusiness economy focus on conserving water in irrigation. A survey of 709 irrigators was conducted in ten counties in Kansas, Nebraska, Oklahoma, and Texas to provide information about the frequency with which irrigators adopted each of 39 water-saving practices and the variation of adopwater-saving practices and the variance was found primarily to be a function of location and secondarily to be influenced by the number of wells, the type of irrigation system, depth to water, age, and educairrigation system, depth to water, age, and educa-tion. Locational differences remained strong even tion. Locational differences remained arroing even when the influence of secondary factors were controlled. The future of irrigated agriculture in the High Plains will undoubtedly be influenced by crop prices, energy costs, state legislative sponses, changes in national farm policy, and the extent of past groundwater depletion. However, extent of past groundwater depletion. However, irrigators can help their situation if they select the most cost effective mix of water-saving practices.
(Korn-PTT) W91-10821

CAUSES OF DEGRADATION OF CHEMICAL AND PHYSICAL PROPERTIES OF CHERNO-ZEMS IRRIGATED WITH NONMINERA-LIZED WATER.

Moscow State Univ. (USSR). Dept. of Soil Science.

For primary bibliographic entry see Field 2G. W91-10913

EFFECT OF LONG-TERM APPLICATION OF FERTILIZERS ON THE AGROPHYSICAL PROPERTIES OF AN IRRIGATED LIGHT-CHESTNUT SOIL.

All-Union Scientific Research Inst. of Irrigated Agriculture, Volgograd (USSR).

For primary bibliographic entry see Field 2G. W91-10914

PHYSICAL PROPERTIES OF IRRIGATED CHERNOZEMS OF THE SOUTHERN

Odesskii Gosudarstvennyi Univ. (USSR). For primary bibliographic entry see Field 2G. W91-10915

ECONOMIC ASSESSMENT OF THE WATER QUALITY BENEFITS OF CONSERVATION TILLAGE ON SOUTHWESTERN ONTARIO CROPLAND.

Guelph Univ. (Ontario). Dept. of Agricultural Ecics and Bu

G. Fox, and E. J. Dickson. IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 485-493, 3 tab. 31 ref.

Descriptors: \*Agricultural water, \*Conservation, \*Conservation tillage, \*Cost-benefit analysis, \*Nonpoint pollution sources, \*Ontario, \*Water pollution control, \*Water quality, Costs, Economic aspects, Sediment control

Non-inversion primary tillage in cash crop production has been promoted as a soil and energy conserving production system for two decades. More recently, it has been linked to improvements in surface water quality, through the reduction of the rate at which sediment is displaced from cropland.

#### Field 3—WATER SUPPLY AUGMENTATION AND CONSERVATION

#### **Group 3F—Conservation In Agriculture**

Four different forms of row crop tillage were analyzed to estimate the effects of conservation tillage on water quality. The Soil Conservation teconomics (SOILEC) model was used to estimate the on-farm impacts of alternative management practices. The Guelph model for evaluating the effects of Agricultural Management systems on Erosion and Sedimentation (GAMES) was used to estimate changes in sediment delivery to streams and lakes resulting from changes in cropland management practices. With one exception, off-farm benefits are larger than on-farm costs. The on-farm const, however, are borne by the farm operator, whereas the off-farm benefits accrue to diverse stakeholders downstream. This is a classic example of an economic externality. Farmers have little incentive to adopt the socially efficient production system since they are not held accountable for the external costs imposed on others. Local matters play a role in the evaluation of costs and benefits of soil conservation. While the adoption of conservation tillage generates improvements in water quality whose value exceeds the costs imposed on farms, this strategy may not be the most cost-effective approach to sediment control. Investments in stream bank rehabilitation, various sedi-ment trapping devices located along waterways, and a reduction of intensity of cultivation near streams and rivers, may generate comparable total benefits at a substantially lower cost than wide-spread use of conservation tillage. (See also W91-11003) (Lantz-PTT) W91-11050

MICRO-TARGETING CROPLAND RETIRE-MENT FOR WATER QUALITY IMPROVE-MENT: MEASURING THE BENEFITS OF IN-CREASED INFORMATION.

nesota Univ., St. Paul. Dept. of Agricultural and Applied Economics

K. Kozloff, and S. J. Taff. IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 507-514, 1 fig,

Descriptors: \*Agriculture, \*Cost-benefit analysis, \*Land use, \*Nonpoint source pollution, \*Water pollution control, Economic aspects, Soil conser-

The relative cost-effectiveness of micro-targeting cropland retirement programs for reducing nonpoint source pollution is examined using a con er model to simulate the effects of various program options in a study watershed with respect to budget outlays for annual rental payments, reduc-tion in downstream sediment and nutrients, and reduction in on-site erosion. Options that incorporated information about heterogeneous economic and physical characteristics across land parcels were more cost-effective than those that did not. The marginal cost-effectiveness of all schemes decreased as the proportion of land retired increased within the watershed. (See also W91-11003) (Author's abstract) W91-11052

IMPLICATIONS OF FULL-COST RECOVERY WATER RATES ON IRRIGATED FARMS IN SASKATCHEWAN

UMA Engineering Ltd., Lethbridge (Alberta). For primary bibliographic entry see Field 6C. W91-11054

MANAGEMENT OF IRRIGATION-INDUCED

MANAGEMENT OF IRRIGATION-INDUCED CONTAMINANTS.
Department of the Interior, Washington, DC. Office of Environmental Affairs.
For primary bibliographic entry see Field 5G. W91-11063

NATIONAL PROGRAM FOR SOIL AND WATER CONSERVATION, ITS EFFECT ON USDA SERVICES.

R. M. Gray, and J. A. Maetzold. IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Man-agement. Freshwater Foundation, Navarre, Minne-

sota. 1989. p 115-124.

Descriptors: \*Agricultural practices, \*Environmental policy, \*Erosion control, \*Management planning, \*Nonpoint pollution sources, \*Watershed management, Agricultural chemicals, Erosion, Groundwater quality, Legislation, Regulations Soil conservations tions, Soil conservation.

The National Conservation Program (NCP) of the US Department of Agriculture (USDA) was developed as part of The Soil and Water Conservation Act of 1977. In the 1982 NCP, USDA analyzed eight resource areas of concern and identilight resource areas of concern and identified three-erosion, upstream flooding, and water conservation—as having the highest priority. As a result of the 1982 NCP, USDA redirected its activities to: focus assistance more sharply on the most critical resource areas; strengthen the particular interests in the contraction of the contrac nership of Federal, State, and local agencies and private organizations; and, improve management of existing conservation programs. For the 1988-97 period, USDA has modified its priorities, and is directing its activities to address the top priorities, which are: (1) reduce the damage caused by exceswhich are: (1) reduce the damage caused by excessive soil erosion on rural lands. In support of erosion control, the Food Security Act of 1985 authorized the establishment of vegetative cover on about 10% (45 million acres) of cropland. Meanwhile, the Highly Erodible Lands Provision will require that farmers who 'sodbust' highly erodible land must have a conservation system in place in order be able to participate in USDA programs; and (2) to protect the quality of surface and groundwater against harmful contamination from agricultural nonpoint sources and thereby maintain the quality of water available for beneficial use. The USDA plans to work with the states and local computative in developing and implecial use. The USDA plans to work with the states and local communities in developing and implementing agrichemical risk management methods. The USDA will also support research activities in these areas as well as administer the ongoing programs that encourage agricultural operators to protect water quality. (See also W91-11162) (Rubinstein-PTT)

AGRISOURCE: THE INFORMATION SYSTEM FOR CROP TECHNOLOGY.

REACH/AgriSource, Cenex/Land O'Lakes, PO Box 64089, St. Paul, MN 55164-0089. For primary bibliographic entry see Field 10D. W91-11196

SOIL TEC: A COMPUTERIZED SOIL-SPECIF-IC FERTILIZER APPLICATION SYSTEM, CENEX/Land O'Lakes, St. Paul, MN 55164-0089. For primary bibliographic entry see Field 7C. W91-11197

FARMER-INITIATED PROJECT TO PRO-MOTE SUSTAINABLE AGRICULTURE IN CO-OPERATION WITH THE EXTENSION SERV-

ICE.

D. E. Exner, and R. L. Thompson.

IN: Agrichemicals and Groundwater Protection:
Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 401-406.

Descriptors: \*Agriculture, \*Information exchange, \*Information transfer, \*Iowa, \*Nonpoint pollution sources, \*Organizations, Farming, Research.

At the Biofarming Workshop held in 1985, a suggestion was made to establish a farmers' organization that would share knowledge gained from farming experience. This organization came to be known as the Practical Farmers of Iowa (PFI). From its inception, PFI has worked to improve the farmer-researcher dialogue by taking the position that both farmers and researchers have an important role to play in the development of sustain agriculture. A source of contention has been that farmers and researchers have not shared a common frame of reference. There is a need for on-farm trials that are convincing to both farmers and scientists and that are simple enough and 'farmable' enough to be carried out completely by farmers. The design used by PFI is the paired-comparison, with at least six pairs of narrow, side-by-side test strips running all the way across the field. PFI has approached both foundations and state agencies for support to extend its on-farm demonstration program. A cooperative arrangement now exists between PFI and the Extension Service. This artween PFI and the Extension Service. Inis arrangement is intended to present sustainable agriculture alternatives to every farmer in the state. PFI will gain access to Extension's well-developed communication network and to the program development skills of its professionals. The Cooperative Extension Service will increase its knowledge base regarding sustainable agriculture, which will improve information delivery both to the farmers and to its own personnel. (See also W91-11162) (Korn-W91-11203

TRICKLE IRRIGATION OF SUNFLOWER WITH MUNICIPAL WASTEWATER.
Agricultural Research Inst., Nicosia (Cyprus).

L. Papadopoulos, and Y. Stylianou. Agricultural Water Management AWMADF, Vol. 19, No. 1, p 67-75, January 1991. 6 tab, 17 ref.

Descriptors: \*Crop yield, \*Fertilizers, \*Nutrient requirements, \*Sunflowers, \*Trickle irrigation, \*Wastewater utilization, Effluents, Municipal wastewater, Nitrogen, Nutrient concentrations, Phosphorus, Plant growth, Potassium, Salinity.

A field experiment was conducted for three years on a Calcaric Lithosol to study the influence of treated municipal wastewater in comparison with freshwater, supplemented with four N or P levels, on soil fertility and on growth and yield of trickle-irrigated sunflower (Helianthus annus L). The N irrigated sunflower (Helianthus annus L). The N concentrations in irrigation water were nil, 30, 60, or 90 mg/L. An efficient use of N, with no residual NO(3)-N in soil, occurred with the additional 30 and 60 mg N/L in wastewater and freshwater, respectively. The maximum seed yield obtained was significantly greater in the effluent-irrigated was significantly greater in the effluent-irrigated with significantly greater in the yield was obtained with the 60 mg N/L(-i). The P levels were nil, 15, 30, or 45 mg/L. With the effluent no supplementary P was needed for high yield of good quality. With treated wastewater less N and no P fertilizers are needed by sunflower for high yield of good quality. (Author's abstract)

WATER USE OF A WINTER WHEAT CULTI-VAR (TRITICUM AESTIVUM).

Akademia Rolnicza, Poznan (Poland). Dept. of Vegetable Crops. T. Islam.

Agricultural Water Management AWMADF, Vol. 19, No. 1, p 77-84, January 1991. 2 fig, 4 tab, 6 ref.

Descriptors: \*Crops, \*Evapotranspiration, \*Irrigation, \*Irrigation requirements, \*Water use, \*Wheat, Bulgaria, Consumptive use, Field capacity, Plant growth, Root zone, Soil moisture.

A field trial with a winter wheat cultivar (triticum aestivum) was conducted at the experimental field of the Introduction and Plant Resources Institute Sadovo, Bulgaria, during 1982-83 and 1983-84. Three treatments, two irrigated and one non-irrigated, were used to determine the water use of winter wheat at the central-eastern region of Bulgaria. Irrigation was given to maintain two soil moisture regimes of 65-70-65% and 75-85-75% of moisture regimes of 65-70-65% and 75-87-75% of field capacity during the periods emergence to jointing, jointing to flowering and flowering to dough stage, respectively. To maintain both the regimes irrigations were required in both the experimental years, but in different growth stages. Among the treatments the non-irrigated one showed the lowest peak evapotranspiration of 3.7 mm/day and the treatment irrigated at 75.88-75% showed the lowest peak evapotranspiration of 3.7 mm/day and the treatment irrigated at 75-85-75% of field capacity showed the highest peak of 5.8 mm/day. The total water use under non-irrigated condition and irrigated at 75-85-75% of field capacity was 335 mm and 482 mm, respectively. Three irrigations during the post-winter period were required to maintain the latter moisture level, which used the highest amount of water among all

#### WATER QUANTITY MANAGEMENT AND CONTROL—Field 4

# Control Of Water On The Surface—Group 4A

the treatments. Both in irrigated and non-irrigated the treatments. Both in irrigated and non-irrigated conditions 50% of the post-winter water use was contributed by the 0-20 cm root zone and no significant difference in soil moisture depletion along the deeper zones by the irrigated or non-irrigated treatments was observed. (Author's abstract) stract) W91-11436

#### 4. WATER QUANTITY MANAGEMENT AND CONTROL

#### 4A. Control Of Water On The Surface

MATHEMATICAL MODELLING FOR RESER-VOIR WATER-QUALITY MANAGEMENT THROUGH HYDRAULIC STRUCTURES: A CASE STUDY

ENGE-RIO, Engenharia e Constuloria S.A., Rio

de Janeiro (Brazil).
For primary bibliographic entry see Field 5G.
W91-10490

DALLAS' FLOOD CAVERNS. For primary bibliographic entry see Field 8A. W91-10493

WATER FUTURES.

Agricultural Research Service, Fort Collins, CO. For primary bibliographic entry see Field 6B. W91-10506

REPORT OF THE RIVER MASTER OF THE DELAWARE RIVER, FOR THE PERIOD DE-CEMBER 1, 1988-NOVEMBER 30, 1989.

Geological Survey, Reston, VA. S. P. Sauer, W. E. Harkness, B. E. Krejmas, and K. E. White.

A. E. Wille.

Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, Co 80225-0425, Open-File Report 90-551, 1990. 89p, 7 fig, 22 tab.

Descriptors: \*Delaware River Basin, \*Legislation, \*Water management, \*Water resources management, \*Water supply, Delaware River, Drought, Flow rates, New Jersey, New York, New York City, Precipitation, Regulations, Runoff, Water

A Decree of the Supreme Court of the United States in 1954 established the position of Delaware River Master. The Decree authorized diversions of River Master. The Decree authorized diversions of water from the Delaware River basin which require compensating releases from certain New York City owned reservoirs to be made under the supervision and direction of the River Master. Reports to the Court, not less frequently than annually, were stipulated. During the 1989 report year, December 1, 1988, to November 30, 1989, precipitation and runoff ranged from below average to above average in the Delaware River basin; for the year as a whole, precipitation was 1.45 inches above average. Reservoir storage in the basin declined into the drought-warning zone of the operation curves for the reservoirs on January 11, 1989 and operations were conducted as prescribed in the Interstate Water Management Recommendations of the Parties to the Decree from January 16 to February 8. From February 9 to April 30 at the request of the Parties to the Decree releases to meet the Montague flow objective were suspended as part of an operation designed to suspended as part of an operation designed to avoid or delay entry into a drought emergency in avoid or delay entry into a drought emergency in the basin. In response to increased precipitation in April and May, storage increased and operations were returned to those prescribed in the Decree on May 12. Storage improved from a low of 45.2% of capacity on February 15, to 99.7% of capacity on June 25, and remained above the median for the remainder of the report year. Diversions from the Delaware River basin by New York City and New Jersey did not exceed those authorized by the terms of the Amended Decree. Releases were

made as directed by the River Master to relieve thermal stress in the streams downstream from the reservoirs at other times. The excess release quantity as defined by the Decree was expended on October 18, 1989 and the Montague design rate was reduced from 1,850 cu ft/s to 1,750 cu ft/s. New York City and New Jersey complied fully with the terms of the Decree and with the directives of the River Master during the year. (Author's abstract) thor's abstract) W91-10765

MACROINVERTEBRATE ALONG A COMPLEX REGULATED STREAM ENVIRONMENTAL GRADIENT.

Colorado State Univ., Fort Collins. Dept. of Biol-

ogy.
N.J. Voelz, and J. V. Ward.
Regulated Rivers Research & Management
RRRMEP, Vol. 5, No. 5, p 365-374, November/
December 1990. 6 fig. 36 ref.

Descriptors: \*Colorado, \*Dam effects, \*Distribu-tion, \*Invertebrates, \*Macroinvertebrates, \*Regu-lated flow, \*Reservoir releases, Dams, Environ-mental gradient, Mathematical models, Model studies, Periphyton, Population dynamics, Temper-

Samples were collected year-round over a one-year period at sites located downstream from a hypolimnetic-release reservoir on the Blue River, Colorado, to examine macroinvertebrate responses Colorado, to examine macroinverteerate responses along a complex environmental gradient induced by river regulation. Six sampling sites were established in riffles downstream of the dam using approximately a geometric progression starting at 0.25 km. Ordination techniques were used to elucidate macroinvertebrate distributional patterns. along the complex environmental gradient. The detrended correspondence analysis showed a se quential faunal gradient with the most rapid change occurring within the first 2.0 km below the impoundment. Detrended canonical correspondence analysis was used to relate faunal distributions to downstream changes in environmental variables. Downstream decreases in periphyton standing crop and minimum temperatures, and downstream increases in food resources and maximum tempera-tures, were identified as the major variables structures, were identified as the major variables struc-turing faunal assemblages. The combined use of different gradient analysis techniques proved useful for identifying distinct macroinvertebrate distribu-tional patterns and the environmental variables that may be responsible for these patterns. (Au-thor's abstract) W91-10848

USE OF NON-PERSISTENT HERBICIDES, GLYPHOSATE, AND 2,4-D AMINE, TO CONTROL RIPARIAN STANDS OF JAPANESE KNOTWEED (REYNOUTRIA JAPONICA

HOUTT). University Coll., Cardiff (Wales). School of Pure and Applied Biology.

D. J. Beerling.
Regulated Rivers Research & Management RRMEP, Vol. 5, No. 5, p 413-417, November/December 1990. 3 fig, 15 ref.

Descriptors: \*Aquatic weed control, \*Herbicides, \*Phenoxy acid herbicides, \*Riparian vegetation, Biomass, Spraying.

The non-persistent herbicides glyphosate and 2,4-The non-persistent herbicides glyphosate and 2,4-D amine were applied to riparian stands of R. japonica on the banks of the River Cynon, South Wales at doses of 2154 g and 2790 g active ingredient/ha respectively, using different spraying regimes. Glyphosate was tested with one or two applications per season, 2,4-D amine with two only. Two weeks after spraying, the biomass and leaf area ratio of shoots in all treated plots was depressed but was significantly lower (P<0.01) in the 2,4-D amine plots. Ten weeks after treatment, shoots began to recover but the biomass was still < 40 % of the control areas. Rapid recovery (six weeks after treatment) of Leaf Area Ratio was also observed. Second applications of glyphosate and observed. Second applications of glyphosate and 2,4-D amine to the respective plots resulted in shoot death after four weeks. Two applications of

2,4-D amine are recommended, one early in the season to reduce vigor and height of R. japonica (which precludes the use of spraying booms and increases the application efficiency) and a second in mid-season to achieve control. Successful control of R. japonica after herbicide treatment is dependent on continued management (further spraying) of treated areas to suppress possible regrowth during the following season. (Medina-PTT) W91-10852

WETLAND IMPOUNDMENTS OF EAST-CEN-TRAL FLORIDA.

Florida Medical Entomology Lab., Vero Beach. For primary bibliographic entry see Field 2L. W91-10854

EXPORTING HIMALAYAN FLOODS.

California Univ., Santa Barbara. Center for Remote Sensing and Environmental Optics. For primary bibliographic entry see Field 2E. W91-11014

FLOOD FORECASTS ON TRANSBOUNDARY RIVERS IN HUNGARY WITH PARALLELS IN

Vizgazdalkodasi Tudomanyos Kutato Intezet, Bu-

vizgazzatkotasi i udomanyos kutato intezet, Budapest (Hungary).

G. Balint, S. Z. Ambrus, and R. Bishop.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 111-117, 1 fig.

Descriptors: \*Canada, \*Flood basins, \*Flood fore-casting, \*Hungary, \*International waters, Danube River, Drava River, Floods, Ipoly River, Koros River, Mountain watersheds, Political aspects, Tisza River

For a country situated downstream of another on a watershed, all hydrological forecasts on upstream watersheet, an introduction of the state of the transboundary rivers have to be obtained from its upstream neighbor. It also puts the downstream country at the mercy of the upstream one, being subject to the results of it incidentally polluting the subject to the results of it incidentally polluting the control structures. Hungary, as a small country having a great number of water courses with frequent flooding problems, faces this problem with all but one of its rivers. All the rivers but the Zagyva originate in the mountainous areas across its borders bringing, more often than not, flash flood events to the Hungarian plain. In this setup, sudden floods can come down the rivers without any advance notice if the information from the neighbors happens to come down the rivers without any advance notice if the information from the neighbors happens to be late. Every neighbor acts differently in this matter. Therefore, the reliability of forecasts depends not only on the hydrological travel time but also on the travel time of information. The latter is a combination of natural and political phenomena. The varying situations on the Danube, Tisza, Koros, Ipoly and Drava Rivers are discussed. The situation in Canada is different because of the different political background However, informasituation in Canada is different because of the different political background. However, information travel may well be blocked here too, by potential bad communication between provinces or even Conservation Authorities. (See also W91-11003) (Author's abstract) W91-11015

REGULATION OF LAKE ONTARIO LEVELS. Corps of Engineers, Buffalo, NY. Water Quality

For primary bibliographic entry see Field 6A. W91-11028

WATER MANAGEMENT IN THE 21ST CEN-

TURY.

A 25th Anniversary Collection of Essays by Eminent Members of the American Water Resources Association. American Water Resources Association, Bethesda, Maryland. AWRA Special Publication No. 89-2, 1989. Sop. Edited by A. Ivan Johnson and Warren Viessman.

#### Field 4—WATER QUANTITY MANAGEMENT AND CONTROL

#### Group 4A-Control Of Water On The Surface

Descriptors: \*Economic aspects, \*Environmental impact, \*Legal aspects, \*Political aspects, \*Social aspects, \*Water management, \*Water resources management, Institutional constraints, Public health, Resources management, Water policy, Water quality management.

A variety of essays, contained in this collection, recognize that water management is multi-dimen-sional, embracing technical, political, social, legal, environmental, and economic elements. Effective management of water resources often depends more on the ability to maneuver within institutionmore on the ability to maneuver within institution-al constraints than to design technologic fixes; it is suggested that there is a need for institutional reform. The six essays specifically address the past, present, and future of water resources manage-ment; the federal role in the solution of future management problems; water and human health; and the dynamics of water policy. (See W91-11207 thru W91-11212) (Fish-PTT)

# PAST, PRESENT, AND FUTURE OF WATER RESOURCES MANAGEMENT IN THE UNITED STATES.

American Water Resources Association, Bethesda,

T. M. Schad.

M. Schad.
 H. Schad.
 H. A 25th Anniversary Collection of Essays by Eminent Members of the American Water Re-sources Association. AWRA Special Publication No. 89-2. American Water Resources Association, Bethesda, Maryland. 1989. p 1-8.

Descriptors: \*Future planning, \*History, \*Water law, \*Water resources, \*Water resources management, \*Water supply, Flooding, Irrigation, Mississippi River, Political aspects, Water quality control, Water resources institutes.

The history of water resources management in the U.S. antedates the Constitution. Water was naturally and abundantly available in the 13 original states. Water resources management at the end of the 18th century consisted of development of springs and wells for drinking and stock water, construction of canals, channel improvements and locks to facilitate water transportation. Flourishing railroads resulted in few improvements for naviga-tion. In the 1870's, however, flooding on the lower Mississippi River and provision for water supplies for irrigation of arid lands in western states were recognized as problems. It was not until 1879 that Congress authorized the creation of the Mississippi River Commission to undertake the improvement of the Mississippi River. The economic depression of the 1930's heralded the creation of the Water Resources Committee of the National Resources Commission, that later metamorphosed into the National Resources Planning Board. Water management plans were initiated for most of the river basins of the U.S. Public sentiment in favor of water pollution control led to authorization of water quality control investigations in the 1950's. The National Water Commission was created in 1968, but offered solutions too drastic for Congressonal approval. Finally, federal responsibility in-creased with the enactment of the 1972 Water Pollution Control Act. The Reagan era ushered in decreased Federal expenditures on nonmilitary programs and returned many responsibilities to the states. Water pollution control legislation in 1988 states. Water poliution control legislation in 1938 turned that attitude around slightly by establishing Federal grants for construction of publicly-owned treatment plants and other facilities for water pollution control. As water resources problems continue to evolve, the Federal government will have to become more involved. Trends suggest that there will be much greater reliance on groundwater. Declining water availability and water quality will force user restrictions. (See also W91-11206) (Mertz-PTT)

#### FUTURE DIRECTIONS FOR WATER RE-SOURCES.

New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources. W. Whipple. IN: A 25th Anniversary Collection of Essays by

Eminent Members of the American Water Resources Association. AWRA Special Publication No. 89-2. American Water Resources Association, Bethesda, Maryland. 1989. p 9-13.

Descriptors: \*Clean Water Act, \*Flood control, \*Future planning, \*Hydroelectric power, \*Water resources, \*Water resources management, Environmental effects, Irrigation, Storm water management, Waste disposal, Water conservation, Water law, Water pollution control, Water resources development, Water supply.

The great era of water resources got well underway with the passage of the Flood Control Act of 1936. For the next 30 years large Federal programs featured flood control, navigation, hydroelectric power, and irrigation. The environmental movement of the 1960's and the Clean Water Act of 1972, created a basic shift in national priorities. As the nation urbanized, environmental pressures became more acute. Water resources development started involving community life. In addition, waste control and disposal programs became ranking activities in the environmental field, encompassing air, land and water environments. As fossil fuels become scarcer in the future, the value of hydroelectric power will increase. Few new projects will be built, however, because the best projects will be built, however, because the best sites remaining cannot be used without unacceptable economic, environmental and social dislocation. Navigation improvements will be maintained and some channels deepened; but few new systems will be built. The planners of flood control will find it ever more difficult to find acceptable new reservoir sites. Further general increases in flood damages appear inevitable, especially along the smaller rivers and streams. Growth in flood damages due to new development can be precluded on a control with the control of the contr ages due to new development can be precluded on small streams, and minimized on larger streams, by programs of stormwater management. As water shortages due to drought become more serious, water conservation will increase in popularity and water conservation will increase in popularity and practicality. By far the greatest change comes with the increasing importance of pollution control. A major technological change in the treatment of water for potable uses will be made when the EPA finally publishes new standards for trihalomethanes. Regional water management plans will be increasingly applied. Urbanization ups the pressures for better planning and more effective environmental protection. Despite our best efforts, a new generation of planners and analysts will have new generation of planners and analysts will have their hands full. (See also W91-11206) (Mertz-PTT) W91-11208

# PAST, PRESENT, AND FUTURE OF WATER USE AND MANAGEMENT.

Academy of Natural Sciences of Philadelphia, PA. R. Patrick

R. Patrick.
III: A 25th Anniversary Collection of Essays by Eminent Members of the American Water Resources Association. AWRA Special Publication No. 89-2. American Water Resources Association, Bethesda, Maryland. 1989. p 15-19.

Descriptors: \*Future planning, \*History, \*Stream pollution, \*Water management, \*Water pollution control, \*Water resources management, \*Water use, Acid mine drainage, Aquifers, Biological oxygen demand, Surface-groundwater relations, Toxicology, Water conservation, Wetlands.

Between 1930 and 1940, waterways were at a low ebb. Pollution was rampant through many of the most important riverine systems. During the 1940's and 1950's, the first real concerns by citizens were surfacing concerning water quality. The first laws implemented focused on reductions of biological oxygen demand and acid mine wastes. At this time, the way to measure the toxicity of a waste to aquatic life was by the 96-hour toxic level median, and sometimes only a 24-hour toxic level median, and sometimes only a 24-hour toxic level median. was used. In 1968 a methodology using three steps in the food web (primary producer, herbivore/ detrivore, and ominivore) was developed. Only recently has that method been put to use. Management of water resources was at a primitive state in the 1960's. Measures were often taken to solve the immediate needs of the user, rather than taking a long-term approach to the problems. Because water was free or very inexpensive, it was often cheaper not to fix a leak. Groundwater was really not known by the general public except as a source of well and spring water. The general philosophy was that it was free and available for the use of all in unlimited quantities. Few appreciated the imporin unlimited quantities. Few appreciated the impor-tance of wetlands as conservation areas for water, nor did they appreciate the fact that shallow aquifers and wetlands were often connected. Today, it is known that air, water, and land all interact and that it is not a solution to remove a pollutant from one phase of the environment and put it in another. Although billions of dollars have been spent on pollution control, very little has been directed into monitoring the results. In the future, the attitude toward water resources and future, the attitude toward water resources and groundwater must change. More care should be given to the conservation of precipitation and off-stream storage that doesn't interfere with the natural flow of streams should be developed. Wetlands are very important regenerators of shallow aquifers and should be preserved. The only way to increase the water supply after groundwaters and surface water are exhausted is to desalinate seawater. At present, this is expensive and produces difficult-to-dispose-of wastes. (See also W91-11206) (Mertz-PTT)

# FUTURE WATER MANAGEMENT PROB-LEMS: THE FEDERAL ROLE IN THEIR SO-LUTION.

Colorado State Univ., Fort Collins.

H. P. Caulfield.

H. F. Caumen.
III: A 25th Anniversary Collection of Essays by Eminent Members of the American Water Resources Association. AWRA Special Publication No. 89-2. American Water Resources Association, Bethesda, Maryland. 1989. p 21-29. 8 ref.

Descriptors: \*Environmental protection, \*Federal jurisdiction, \*Future planning, \*Rehabilitation, \*Water management, \*Water resources management, Clean Water Act, Economic aspects, Greenhouse effect, Water conservation, Water resources, Water resources development.

Federal dominance in water resources development is dead, whereas dominance is increasing in the control and implementation of environmental protection. In the 21st Century water quality will continue to be a major water management problem. The sources of pollution are so great and the problems of control so intractable that these water management problems will continue indefinitely into the future. The Federal role is inescapable. Consumptive use versus instream flow will be a primary water management problem in the 21st Century. Ideological support for continued economic and population growth will be pitted, even more sharply than at present, against strong environmental beliefs on the need to retain and in some cases restore instream flows. Section 404 of the Clean Water Act of 1972 already gives the Federal Government the power to resolve such issues through the Army Corps of Engineers and ultimately the EPA. The greenhouse effect may be a national problem in the 21st Century, involving the location of agriculture, the flooding of coastal areas, the rise in the salt front in coastal rivers, and the development of new sources of municipal and Consumptive use versus instream flow will be a areas, the rise in the sait front in coastal rivers, and the development of new sources of municipal and industrial water. A large Federal outlay will be necessary to achieve timely solutions to water management problems. In this connection the Federal Government will have the option to provide funds for necessary rehabilitation of existing Federal water management revisities or to abandon them. al water management projects or to abandon them. The major water management problems of the U.S. will also be worldwide problems. (See also W91-11206) (Mertz-PTT) W91-11210

#### DYNAMICS OF WATER POLICY.

Florida Univ., Gainesville. For primary bibliographic entry see Field 6E. W91-11212

RISK-BASED PERFORMANCE CRITERIA FOR REAL-TIME RESERVOIR OPERATION.

#### WATER QUANTITY MANAGEMENT AND CONTROL—Field 4

### Groundwater Management—Group 4B

Manitoba Univ., Winnipeg. Dept. of Civil Engi-

D. H. Burn, H. D. Venema, and S. P. Simonovic. Canadian Journal of Civil Engineering CJCEB8, Vol. 18, No. 1, p 36-42, February 1991. 6 fig, 10

Descriptors: \*Algorithms, \*Model studies, \*Reservoir design, \*Reservoir operation, \*Reservoirs, \*Streamflow forecasting, Design criteria, Forecasting, Operating policies, Optimization, Safety, Systems analysis, Systems engineering, Tradeoffs.

Water resources projects traditionally have been designed and operated with the objective of optimizing economic performance (i.e., maximizing net benefits, minimizing expected damages, etc.). More recently, the importance of additional performance in the design or operation of water resources sys-tems has been recognized. Reliability, resiliency, and vulnerability have been formulated as risk-based performance measures for the evaluation of a based performance measures for the evaluation of a real-time reservoir optimization model. The reser-voir operation model includes a multi-objective compromise programming algorithm to select, in real time, an optimal operating horizon for the reservoir. The utility of the risk-based performance criteria for comparing operational strategies result-ing from the selection of different parameters for the compromise programming algorithm is demon-strated. Although tradeoffs exist among the three strated. Attnough tradeous exist among the three performance evaluators, appropriate compromises can be reached among conflicting modeling goals. Any rational comparison of candidate operating strategies must consider the multi-dimensional character of the operational problem within the selection process. The work demonstrates that preferred operating strategies, in terms of risk-based performance criteria, can be selected in a systemat-ic manner. (Author's abstract) W91-11275

BECK FLOOD-ALLEVIATION FENAY SCHEME

Babtie Dobbi, Consulting Engineers, Croydon, Surrey, England. For primary bibliographic entry see Field 8A.

REGULATION OF INTERBASIN TRANSFERS AND CONSUMPTIVE USES FROM THE GREAT LAKES.

For primary bibliographic entry see Field 6E. W91-11384

W91-11365

MANAGING WATER RESOURCES IN LATIN

Economic Commission for Latin America and the Caribbean, Santiago (Chile). For primary bibliographic entry see Field 6B.

W91-11385 AGENCY AUTONOMY IN TRANSBOUNDARY

RESOURCE MANAGEMENT: THE UNITED STATES SECTION OF THE INTERNATIONAL BOUNDARY AND WATER COMMISSION, UNITED STATES AND MEXICO. Colorado State Univ., Fort Collins. Dept. of Politi-For primary bibliographic entry see Field 6E. W91-11388

FLOOD-HAZARD ZONATION IN ARID LANDS. Geological Survey, Tucson, AZ. For primary bibliographic entry see Field 6F. W91-11390

SOLUTION IN CLOSED FORM AND A SERIES SOLUTION TO REPLACE THE TABLES FOR THE THICKNESS OF THE EQUIVALENT LAYER IN HOOGHOUDT'S DRAIN SPACING

Agricultural Univ., Wageningen (Netherlands). For primary bibliographic entry see Field 2G. W91-11430

PHOTOGRAPHS WRITTEN HISTORICAL AND DESCRIPTIVE DATA. National Park Service, San Francisco, CA. West-

ern Region. For primary bibliographic entry see Field 6E. W91-11577

ANALYSIS OF ALTERNATIVE MODIFICA-TIONS FOR REDUCING BACKWATER FLOODING AT THE HONEY CREEK COAL STRIP MINE RECLAMATION SITE IN HENRY COUNTY, MISSOURI. Geological Survey, Rolla, MO. Water Resources Div.

For primary bibliographic entry see Field 2E. W91-11595

# 4B. Groundwater Management

GEOHYDROLOGIC EVALUATION OF SPRING SITES AT SOCIAL CIRCLE, GEOR-GIA, DECEMBER 5-8, 1988. Geological Survey, Doraville, GA. For primary bibliographic entry see Field 2F. W91-10765

CHARACTER AND EVOLUTION OF THE GROUND-WATER FLOW SYSTEM IN THE CENTRAL PART OF THE WESTERN SAN JOAQUIN VALLEY, CALIFORNIA. For primary bibliographic entry see Field 2F. W91-10772

GROUNDWATER MANAGEMENT MODEL FOR SALT LAKE COUNTY, UTAH WITH SOME WATER RIGHTS AND WATER QUALITY CONSIDERATIONS.

Utah State Univ., Logan. Dept. of Civil and Envi-

Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
U. Lall, and Y. C. Lin.
Journal of Hydrology JHYDA7, Vol. 123, No. 3/
4, p 367-393, March 1991. 6 fig, 5 tab, 30 ref. Office of Water Resources Research, Department of the Interior Contract 14-08-0001-1072.

Descriptors: \*Groundwater management, \*Model studies, \*Water management, \*Water quality standards, \*Water rights, Economic aspects, Descriptors: "Groundwater management, "Mactor studies, "Water management, "Water quality standards, "Water rights, Economic aspects, Groundwater potential, Legal aspects, Optimization, Salt Lake County, Urban areas, Utah, Water demand, Water supply, Wells.

A distributed parameter, unit response formulation was developed for investigating strategies for managing groundwater use in an urban situation with aging groundwater use in an urban situation with competing water supply agencies considering economics, restrictions on drawdown, water rights and water quality maintenance. The model is deterministic and considers a single multi-year planning period. Water quality management issues are considered through aquifer flow control. Groundwater rights of individual water supply agencies are handled by accounting for groundwater flow across agency boundaries and by restricting well drawdowns. A response matrix formulation was used to develop a compact, nonlinear optimization model. Penalty Successive Linear Programming (PSLP) is used for model solutions. Example applications of the model to Salt Lake County, Utah are made for various demand scenarios such as uniform demand, demand growth and drought condimade for various demand scenarios such as uni-form demand, demand growth and drought condi-tions. The results from these applications show that economics, water quality and water rights consid-erations, as well as the spatial and temporal distri-bution of demand are important factors in deter-mining optimal groundwater development. (Agos-tine-PTT) W01.10011 W91-10911

EMBEDDING AND RESPONSE MATRIX TECHNIQUES FOR MAXIMIZING STEADY-STATE GROUND-WATER EXTRACTION; COMPUTATIONAL COMPARISON.

Utah State Univ., Logan. Dept. of Agricultural and Irrigation Engineering. For primary bibliographic entry see Field 2F. W91-10954

RELATIONSHIP OF REGIONAL WATER QUALITY TO AQUIFER THERMAL ENERGY STORAGE.

Battelle Pacific Northwest Labs., Richland, WA. For primary bibliographic entry see Field 5C. W91-11082

MAPS OF THE '400-FOOT,' '600-FOOT,' AND ADJACENT AQUIFERS AND CONFINING BEDS, BATON ROUGE AREA, LOUISIANA. Geological Survey, Baton Rouge, LA. Water Resources Div.

For primary bibliographic entry see Field 2F.

W91-11086

AVAILABILITY OF GROUND WATER FROM UNCONSOLIDATED DEPOSITS IN MOHAWK RIVER BASIN, NEW YORK.

Geological Survey, Albany, NY. Water Resources

For primary bibliographic entry see Field 2F. W91-11104

EVALUATION OF THREE SCENARIOS OF GROUND-WATER WITHDRAWAL FROM THE MISSISSIPPI RIVER ALLUVIAL AQUIFER IN NORTHWESTERN MISSISSIPPI.

Geological Survey, Jackson, MS. Water Resources Div.

M. J. Mallory.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 90-103, 1990. 6p, 11 fig, 3

Descriptors: \*Conjunctive use, \*Groundwater Descriptors: "Conjunctive use, "Oroundwater management, "Groundwater resources, "Ground-water withdrawal, "Mississippi River, "Surface-groundwater relations, Data interpretation, Groundwater movement, Mississippi, Model studies, Pumping, Water level.

The US Army Corps of Engineers, Vicksburg District, is investigating the feasibility of a project to supply surface water to agricultural water users to reduce the pumping stress on the Mississippi River alluvial aquifer in northwestern Mississippi. Three scenarios of groundwater withdrawal from the aquifer are evaluated using an existing ground-water flow model. The three scenarios represent: water flow model. The three scenarios represent:

(1) a projection of current trends of groundwater
pumpage; (2) groundwater pumpage that could be
expected with the proposed surface water diversion project supplying surface water to many of
the current groundwater users; and (3) groundwater
pumpage that could be expected with the surface water diversion project in operation and with
the remaining groundwater users following best
available technology water conservation practices.
Results for the first scenario indicate that the aquifer would be completely dewatered in some locations as early as 2007 and that, by 2030, the aquifer underlying an area of more than 800,000 acres of
the Delta (northwestern Mississippi) would be
completely dewatered. Results for the second scenario show a dramatic decrease in the rate of
decline of groundwater levels as compared to the nario show a dramatic decrease in the rate of decline of groundwater levels as compared to the first scenario. In 2030, under the second scenario, about three-fourths of the Delta would have a saturated aquifer thickness of > 100 ft. Water level declines from 1985 levels would be greatest in southern Sunflower and northeastern Washington Counties, and generally would be < 50 ft in these areas. The third scenario resulted in a substantial incremental decrease in the rate of decline of water levels Maximum declines from 1985 levels under levels. Maximum declines from 1985 levels under this scenario generally are < 30 ft, an increase of about 20 ft from the second scenario. Saturated thickness is increased by a similar amount. (Author's abstract) W91-11106

WATER MANAGEMENT IN THE 21ST CEN-

nary bibliographic entry see Field 4A. For prin W91-11206

# Field 4—WATER QUANTITY MANAGEMENT AND CONTROL

### **Group 4B—Groundwater Management**

HYDROLOGICAL CONSEQUENCES OF ARTI-FICIAL DRAINAGE OF GRASSLAND. Ministry of Agriculture, Fisheries and Food, Cambridge (England). Field Drainage Experimental

For primary bibliographic entry see Field 2G. W91-11347

SOCIO-ECONOMIC IMPACT OF IMPROVED WELLS IN RURAL SIERRA LEONE.
Njala Univ. Coll., Freetown (Sierra Leone). Dept. of Environmental Studies and Geography.
For primary bibliographic entry see Field 6B.
W91-11358

GROUNDWATER DEPLETION IN INDIA: INSTITUTIONAL MANAGEMENT REGIMES. California Univ., Berkeley. Dept. of Forestry and Resources Management.

M. G. Chandrakanth, and J. Romm.
Natural Resources Journal NRJOAB, Vol. 30, No. 3, p 485-501, 1990. 3 fig.

Descriptors: \*Groundwater depletion, \*Groundwater management, \*India, \*Irrigation effects, \*Legal aspects, \*Water resources management, Groundwater recharge, Irrigation practices, Political aspects, Public policy, Water policy, Water

Historically, irrigation tanks served as important sources of groundwater recharge in the hard rock belt of India. Construction and maintenance of irrigation tanks were functionally linked with irrigation wells by groundwater recharge. Farmers voluntarily maintained the tanks because of an established tank maintenance system. Contemporary administrative and political changes have both promoted rapid exploitation of groundwater and discouraged maintenance of the tank systems that had sustained the groundwater resource leading to depletion. One corrective policy being considered depletion. One corrective policy being considered is the revitalization of tank systems for surface irrigation, groundwater management, and silt fertilization. Tank investments become more attractive when their groundwater and soil fertility effects are considered. Another policy is the removal of subsidies on electricity and credit for pump irrigation. A third is to establish groundwater districts to enforce a system of correlative rights through groundwater quotas in order to enable farmers to secure a predictable annual quantity of water. (Doyle-PTT)

HYDROGEOLOGY, WATER QUALITY, AND GROUND-WATER DEVELOPMENT ALTERNATIVES IN THE LOWER WOOD RIVER GROUND-WATER RESERVOIR, RHODE

ISLAND.
Geological Survey, Providence, RI. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-11572

EVALUATION OF SITE-SELECTION CRITE-RIA, WELL DESIGN, MONITORING TECH-NIQUES, AND COST ANALYSIS FOR A GROUND-WATER SUPPLY IN PIEDMONT CRYSTALLINE ROCKS, NORTH CAROLINA. For primary bibliographic entry see Field 2F. W91-11596

#### 4C. Effects On Water Of Man's Non-Water Activities

KANSAI INTERNATIONAL AIRPORT PROJECT AND ENVIRONMENTAL IMPACT

ASSESSMENT.
Coordination Department, Kansai International Airport Co., Ltd, 3-11-10 Minami-senba, Chuo-ku, Osaka, 342 Japan. M. Maeda

Marine Pollution Bulletin MPNBAZ, Vol. 23, p. 349-353, 1991. 4 fig.

Descriptors: \*Airports, \*Coastal waters, \*Coastal zone management, \*Construction, \*Environmental effects, \*Environmental impact, \*Japan, \*Kansai International Airport, \*Sea walls, Chemical oxygen demand, Conservation, Drainage systems, Drainage water, Land reclamation, Osaka Bay, Seto Inland Sea, Water pollution prevention.

The Seto Inland Sea is one of the typical enclosed coastal seas of Japan. Kansai International Airport is under construction in Osaka Bay, 5 km off the coast of Senshu. The construction of seawalls in the airport island commenced in January 1987. the arport issued commenced in January 1887. With the opening of the airport scheduled for the spring of 1993, the construction of aboveground facilities will soon commence. The concentration of COD in drainage waters from the airport is very of COD in drainage waters from the airport is very low (0.003 ppm) at a location approximately 500 m from the airport, causing minimal change in COD concentration distributions in the marine area. Construction of this airport, designed as a key international airport in Japan, is being supervised as a national project. In Osaka Bay, land reclamation is strictly controlled by provisions in the Special Law for Environmental Conservation in the Seto Inland Sea. Special emphasis has been placed on preventing environmental Conservation in and on preventing environmental pollution in and around Osaka Bay, and conserving the natural environment in preparation of the airport plan, as well as in assessing environmental impact prior to construction. (Author's abstract)

EFFECTS OF LAND-USE BUFFER SIZE ON SPEARMAN'S PARTIAL CORRELATIONS OF LAND USE AND SHALLOW GROUND-WATER **OUALITY** 

Geological Survey, Trenton, NJ. L. E. Hay, and W. A. Battaglin.

Available from the US Geological Survey, Books and Open-File Reports Section, Federal Center, Box 25425, Denver, CO 80225-0425. Water-sources Investigations Report 89-4163, 1990. 28p, 8 fig, 6 tab, 21 ref

Descriptors: \*Data interpretation, \*Environmental effects, \*Groundwater quality, \*Land use, \*Non-point pollution sources, \*Statistical analysis, point pollution sources, \*Statistical analysis, \*Urban runoff, \*Water pollution sources, Buffer zones, Monitoring, New Jersey, Water quality con-

Significant correlations were observed between Significant correlations were observed between land use and shallow groundwater quality in the Coastal Plain of New Jersey. The strength of the correlation varies with the size of the land use buffer used for the analysis. Sets of circular buffers with 1-, 250-, 400-, 600-, 800-, 1,000-, and 1,200-meter radii were generated around 41 wells for which water quality data were available to determine the buffer size that maximizes these correlations. tions. A geographic information system was used to estimate the percentage of urban, undeveloped, and agricultural land within each circular buffer. Spearman's partial correlations were used to lessen closure effects and to minimize skewing of land use and water quality data distributions. The largest number of significant partial correlations (probability level < or = to 0.05) occurred between constituents and percent of urban land, with the effect of agricultural land removed. For this case, 13 of 35 constituents had one or more significant partial correlations. Nine of the 13 relations having signifi-cant correlations reached their maximum correlation value when land use was quantified within buffers with 800, or 1,200-meter radii. Significant-ly correlated variables showed a general pattern: partial-correlation magnitude tended to decrease monotonically as buffer size increased or decreased away from the size at which the maximum correlation occurred. (Author's abstract)

UPDATE OF FLOOD-FLOW CHARACTERIS-TICS OF NANCY CREEK AT GEORGIA HIGH-WAY 400 EXTENSION NEAR ATLANTA, GEORGIA.

Geological Survey, Doraville, GA. For primary bibliographic entry see Field 2E. W91-10762

LAND USE, WATER USE, STREAMFLOW CHARACTERISTICS, AND WATER-QUALITY CHARACTERISTICS OF THE CHARLOTTE HARBOR INFLOW AREA, FLORIDA.

Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Feder-al Center, Denver, Co 80225-0425. Water-Supply Paper 2359-A, 1990. 64p, 26 fig, 29 tab, 106 ref.

Descriptors: \*Charlotte Harbor, \*Environmental effects, \*Florida, \*Hydrologic budget, \*Land use, \*Peace River, \*Water quality, \*Water resources development, \*Water use, Aquifers, Competing use, Groundwater resources, Human population, Surface-groundwater relations, Water demand, Water pollution sources.

Charlotte Harbor is a 270 sq mi estuarine system in west-central Florida. It is being subjected to increasing environmental stress by rapid population growth and development. The Charlotte Harbor inflow area includes about 4,685 square miles; the Myakka, the Peace, and the Caloosahatchee are the major rivers emptying into the harbor. Water use in the inflow area is about 565 million gallons per day (gpd), of which 59% is used for irrigation, 26% for industry, 11% for public supply, and 4% for rural supply. Total freshwater inflow from the three major rivers, the coastal area, and rainfall directly into Charlotte Harbor averages between 5,700 and 6,100 cu ft/sec, which is more than 3,500 directly into Charlotte Harbor averages between 5,700 and 6,100 cu ft/sec, which is more than 3,500 million gpd. A trend analysis of about 50 years of streamflow data shows a statistically significant decreasing trend for the Peace River stations at Bartow, Zolfo Springs, and Arcadia. In the Peace River, the decrease in flow may be related to a long-term decline in the potentiometric surface of the underlying Floridan aquifer system, which resulted from groundwater withdrawals. If this trend continues at the same rate, then excent for brief continues at the same rate, then, except for brief periods of storm runoff, the Peace River at Zolfo Springs could be dry year-round in about 100 years. Of the 114 facilities permitted to discharge domestic or industrial effluent to waters tributary domestic or industrial effluent to waters tributary to Charlotte Harbor, 88 are in the Peace River basin. Phosphate ore and citrus processing account for most of the industrial effluent. By 2020, the population in the inflow area is expected to increase by more than 500,000 people. They will require an additional 76 million gpd for water supply. The increased population will produce an additional 60 million gpd of domestic wastewater, which could result in an additional 3 tons per day of nitrogen and 0.65 ton per day of phosphorus. More than 150 square miles of land will be conmore than 130 square miles of fand will be converted to urban uses, which will produce another 0.25 ton per day of nitrogen from urban runoff. These increased nutrient loads can be expected to occur concurrently with decreased freshwater inflow. (Lantz-PTT)

AQUATIC MACROINVERTEBRATES OF THE ST. FRANCIS SUNKEN LANDS IN NORTH-EAST ARKANSAS.

Forest Service, Glenwood, AR.

Porest Service, Otenwood, AR. B. G. Cochran, and G. L. Harp. Proceedings of the Arkansas Academy of Science AKASAO, Vol. 44, p 23-27, 1990. 1 fig, 2 tab, 32 ref. Arkansas Game and Fish Commission Research Grant (Dingell Johnson Project F-42).

Descriptors: \*Arkansas, \*Channel improvement, \*Distribution patterns, \*Limnology, \*Macroinvertebrates. \*River training, \*Seasonal distribution, Enstroution patterns, "Limnology, "Macroinvertebrates, "River training, "Seasonal distribution, "Species diversity, "Water level, Agricultural watersheds, Aquatic habitats, Ecosystems, Oxbow lakes, Regulated flow, Substrates, Water pollution effects, Watersheds.

A study was conducted to survey the aquatic macroinvertebrate diversity of the St. Francis Sunken Lands in northeast Arkansas. Secondary objectives were a determination of their relative abundance and distributional and seasonal patterns. adundance and distributional and seasonal patterns. Sixty semi-annual collections were made from 30 stations by sampling each station 2 times for 1.5 man-hours with a dip net. Totals of 243 taxa and 13,952 organisms were recorded for the sample period (August 1987-July 1988). Each station was

# Effects On Water Of Man's Non-Water Activities—Group 4C

assigned to 1 of 4 associations, distinguished by distinct physical factors within the river channels and immediate watershed. The Old River Channel-Oxbow Association exhibited the most complex and stable community structures; this was attributed to the relative lack of man's alteration of the habitat. The Channelized Ditches-Point Source Pollution Association demonstrated obvious detri-mental effects of man's intervention. The relatively simple community structures of the St. Francis Lake-Open Water Association were attributed to the typically homogeneous substrates of this area. The simplest community structures were in the Channelized Ditches-Intense Agriculture Associa-tion and were a direct result of man's multiple alterations within the river channels and immediate watershed. Seasonal species diversity indices and numbers of taxa varied inversely with respect to numbers of taxa varied inversely with respect to water level. High values occurred during low-water periods, whereas lower values occurred during high-water periods. This inverse relation-ship was attributed to flooded habitat, which led to population dilution and diminished collecting suc-cess. (Author's abstract) W91-10844

EFFECT OF LAND DEVELOPMENT ON GROUNDWATER RECHARGE DETERMINED FROM NON-STEADY CHLORIDE PROFILES. Queensland Dept. of Primary Industries, Brisbane (Australia). Soil Conservation Research Branch. Journal of Hydrology JHYDA7, Vol. 124, No. 1/ 2, p 43-58, April 1991. 6 fig, 3 tab, 28 ref.

Descriptors: \*Australia, \*Chlorides, \*Groundwat Descriptors: "Australia, "Chiorides, "Croundwai-er recharge, "Infiltration, "Land clearing, "Land management, "Land use, "Soil-water-plant rela-tionships, Acacia trees, Catchment areas, Crop-land, Model studies, Soil water, Solute transport, Vegetation effects.

The effect of clearing and subsequent crop and pasture growth on recharge to groundwater was investigated in three experimental catchments in the brigalow (Acacia harpophylla) lands of north-eastern Australia. Recharge was calculated from soil chloride data, using a simple transient solute mass balance model. Clearing had a substantial initial effect on groundwater recharge, with average recharge rates of 29-70 mm/yr in two cleared catchments, compared with 7 mm/yr in an uncleared catchment. These results were attributed to cleared catchment. These results were attributed to record high rains that fell while both cleared catchments were bare of vegetation, before crops or pastures were established. The effect was only or pastures were established. The effect was only short-lived, however, with no significant recharge occurring in any of the three catchments during the period in which crops and pastures were fully established. This lack of recharge was contrary to the general belief that clearing and establishment of crops or pastures causes a sustained increase in groundwater recharge. The low recharge rates at this site were attributed to the slowly permeable soils and the climate of the study site, where potential evaporation exceeds average rainfall in all soils and the climate of the study site, where poten-tial evaporation exceeds average rainfall in all months, and to the water use characteristic of brigalow. Brigalow is shallow-rooted, and at this site generated lower soil water deficits than either crops or pastures. Clearing is unlikely to result in high water tables in these soils under pastures or opportunity cropping systems under the average climatic conditions of the region. The simple tran-sient solute mass balance model used to estimate recharge rates gave important and significant difstent solute mass balance model used to estimate recharge rates gave important and significant differences in recharge when compared with a more commonly used steady-state model. All recharge rates calculated with the steady-state model were <1.8 mm/yr (most <0.3 mm/yr), and so this model could not identify the gross short-term recharge response to clearing at this site. (Author's W91-10991

POLITICAL ECONOMIC MODEL OF INTERNATIONAL POLLUTION.

Minnesota Univ., St. Paul. Dept. of Agricultural and Applied Economics. For primary bibliographic entry see Field 5B. W91-11016

EFFECTS OF CHANGES IN LAND USE ON ANNUAL STREAMFLOWS IN THE LAKE HURON BASIN OF CANADA AND THE UNITED STATES.

UNITED STATES.
Geological Survey, Reston, VA.
A. G. Scott, and R. B. Phinney.
IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 171-179, 3 fig,

Descriptors: \*Annual runoff, \*Environmental effects, \*International waters, \*Lake Huron, \*Land use, \*Streamflow, Agriculture, Canada, Deforestation, Precipitation, Rainfall-runoff relationships, Statistical analysis, United States, Urbanization.

Major changes in land use have occurred in the Great Lakes basin in Canada and the United States during the past several hundred years. Some of the documented changes include deforestation of large areas of agricultural uses, timbering for paper production, large increases in urbanized areas, development of recreational areas and home sites in rural areas, and installation of subsurface drainage for agriculture. These changes may have altered the runoff characteristics of the basin. Streamflow records for 10 gaging stations in the Lake Huron Basin for which annual streamflows were not sig-nificantly regulated were analyzed to determine trends in annual streamflows could be whether trends in annual streamflows could be identified once the variability of precipitation was taken into account. Length of record ranged from 31 to 71 years, and basin size ranged from 150 to 3,980 sq km. The streamflow records were analyzed by regressing annual mean streamflow against annual precipitation. The correlation between the regression residuals and time was quantified accordance and the streamflow and the strea tweet the regression residuans and time was quanti-fied nonparametrically by use of Spearman's rank-order correlation coefficient (rho) and tested for significant trends. A significant (p-level < 0.10) upward trend in streamflow was indicated for four sites, a downward trend at two sites, and no trend at four sites. Multiple-linear regression equations of the logarithm of annual mean streamflow as a function of the logarithm of annual precipitation and year were computed for each site. Annual mean streamflow was computed for the beginning and ending year of record for each site using these equations and the mean annual precipitation in the corresponding basin. An estimated average change in annual-mean streamflow, of 21%, was computed for the six tributary sites for which significant trends in annual streamflow were determined. This investigation indicates that changes in the hydroat four sites. Multiple-linear regression equations of investigation indicates that changes in the hydrologic response of these tributary basins to precipitation occurred concurrently with changes in land use or agricultural practices. (See also W91-11003) (Author's abstract) W91-11021

PROVINCIAL GUIDELINES TO GREAT LAKES SHORELINE MANAGEMENT PLANS. Ontario Ministry of Natural Resources, Toronto. Conservation Authorities and Water Management

For primary bibliographic entry see Field 6E. W91-11024

ROAD SALTING IMPACTS IN MASSACHU-

Normandeau Engineers, Inc., Concord, NH J. K. Barrett, and M. P. Dillis. IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 515-524, 4 fig, 2 tab.

Descriptors: \*Deicers, \*Environmental impact, \*Highway icing, \*Highways, \*Massachusetts, \*Water pollution sources, Cost-benefit analysts, Drinking water, Ice, Public health, Snow, Sodium,

Impacts from snow and ice control activities were evaluated on the Massachusetts State Highway network for the Massachusetts Department of network for the Massachusetts Department of Public Works (MDPW) Snow and Ice Control Program Generic Environmental Impact Report (GEIR), released in April, 1989. The GEIR evalu-ated MDPW's snow and ice control program and

the social, environmental, health, and economic implications of deicing chemical and abrasive use. implications of decing chemical and abrasive use. Statistical analyses were performed to develop re-lationships between road salt application rates and accident frequency using MDPW's Material Con-trol System, a computerized data bank listing total salt use, application rates and spreader route length for each spreader truck, and storm event. An ex-tensive literature search, provided statistical relator each spreader truck, and storm event. An extensive literature search provided statistical relationships between road salt application rates, annual corrosion costs and health impacts. Literature searches were also used to develop the environmental impact costs and economic benefits to commerce related to snow and ice control. This analysis concluded that snow and ice control provided execution benefits in the activations of the control provided execution benefits in the activation of the control provided execution benefits in the activation of the control provided execution benefits in the activation of the control provided execution benefits in the activation of the control provided execution benefits and the control provided execution of the control provided execution benefits and the control prov analysis concluded that show and ice control provided economic benefits in the categories of traffic safety and commerce but created costs in the categories of corrosion, public health and the environment. Surprisingly, health effects related to sodium in drinking water were found to be very low in comparison to corrosion costs. Environmental costs were also small compared to corrosion but this new to day to the last of the safetitation in the contractivities in the contractivi this may be due to the lack of quantitative informa-tion. The GEIR concluded that road salt impacts could be significantly reduced and substantial fi-nancial savings achieved by optimizing road salt use. (See also W91-11003) (Author's abstract) W91-11053

STUDIES ON ASSESSMENT OF WATER BAL-ANCE AND ITS QUALITY IN GURPUR RIVER BASIN, KARNATAKA STATE, INDIA.

Mangalore Univ. (India). Dept. of Chemistr For primary bibliographic entry see Field 5B. W91-11065

EFFECTS OF LAND USE ALTERATION ON TROPICAL CARBON EXCHANGE. Butler Univ., Indianapolis, IN. Holcomb Research

J. Molofsky, E. S. Menges, C. A. S. Hall, T. V. Armentano, and K. A. Ault. IN: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemi-sphere Publishing Corporation, New York. 1990. p 87-100. 2 fig, 7 tab, 61 ref.

Descriptors: \*Air pollution, \*Carbon cycle, \*Computer models, \*Deforestation, \*Forests, \*Land development, \*Land use, \*Mathematical models, \*Model studies, \*Tropical areas, Agriculture, Air pollution sources, Air temperature, Biomass, Cultivation, Path of pollutants, South America, Southeast Asia, Wetlands.

The net annual release of carbon from tropical The net annual release of carbon from tropical forests of the world is estimated to range from 0.6 to 1.1 billion tons (Gt), based on computer model simulations. The simulations incorporate the most recent data on tropical land use change, regional differences in biomass and soil carbon density, and the conversion of forest to both shifting cultivation. and to permanent agriculture. Carbon accumula-tion in fallow and immature forests and in organic soil wetlands also is included. In general, biomass increases with temperature and moisture. Model simulations indicate that releases of 0.30 to 0.48 Gt/yr occur in South America, the region with the largest forest area, although deforestation rates are lower than the global average. In Southeast Asia, where mean regional forest biomass is high, carbon release rates range from 0.17 to 0.34 Gt/yr. The simulated releases are significantly lower those resulting from some earlier analyses which resulting from some earlier analyses which evaluated less detailed data on land-use change and carbon densities. The results suggest that tropical forests, when compared to fossi-hele sources, are presently a relatively small carbon source. Howevpresently a relativety small carbon source. However, understanding of the biosphere's role in the global carbon cycle requires further refinement in analysis of the many asynchronous regional carbon pools. (See also W91-11066) (Author's abstract) W91-11072

CHANNEL TUNNEL AND ITS IMPACT ON THE FOLKESTONE AND DISTRICT WATER R. B. Monk.

Journal of the Institution of Water and Environ-

# Field 4—WATER QUANTITY MANAGEMENT AND CONTROL

# Group 4C-Effects On Water Of Man's Non-Water Activities

mental Management JIWMEZ, Vol. 5, No. 1, p 72-79, February 1991. 6 fig, 1 tab.

Descriptors: \*Aquifers, \*England, \*Pipelines, \*Tunnels, \*Water districts, \*Water supply, Drainage, Interagency cooperation, Saline water intrusion, Water distribution.

The construction of the Eurotunnel below the English Channel to connect England and France has had a marked impact on the operations of the Folkestone and District Water Company. The tunnel forms a conduit running through the Company's principal aquifer and into the sea. There is a possibility of drainage of the water from the aquifer and saline water intrusion into the aquifer from the sea. To supply the water demands of tunnel construction, numerous mains had to be constructed by the company and the tunnel siting also affected numerous mains, service reservoirs, spring overflows, and filter washwater drains. In addition, water supplies had to be constructed for the Cheriton rail terminal site. When tunneling operations began, movement in the Castle Hill landslip caused leakage from the water main in Castle Hill and movement of an adjacent steel gas main. Regular monitoring through observation boreholes will tell if the tunnel project has had any effect on the Chalk and Lower Greensand aquifers. Although the tunnel project has necessitated extensive but temporary additions to the distribution system, many possible uses can be made of the new pipelines. Close liaison between the water district and the tunnel project managers has facilitated tunnel construction and afforded numerous benefits and renovations to the water district. (Geiger-PTT) W91-11363

SIMAZINE CONCENTRATIONS IN A STREAM DRAINING AN AGRICULTURAL CATCHMENT

STREAM DRAINING AN AGRICULTURAL CATCHMENT.
Institute of Hydrology, Wallingford (England).
R. J. Williams, S. C. Bird, and R. W. Clare.
Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 5, No. 1, p 80-84, February 1991. 3 fig, 1 tab, 19 ref. Department of the Environment Contract PECD 7/7/170.

Descriptors: \*Herbicides, \*Nonpoint pollution sources, \*Path of pollutants, \*Pipelines, \*Simazine, \*Stream pollution, Agricultural runoff, Rainfall-runoff relationships.

Levels of simazine herbicide were measured in streams draining a small agricultural catchment after two successive rainfall events. The stage of the streams was recorded by weirs that triggered automatic samplers after rainfall events. Samples were analyzed for simazine by gas chromatography-mass spectrophotometry. Simazine was applied to hop yards within the catchment between 16 and 20 February 1889 at a rate of 1.7 kg/ha over a total area of 7.9 ha. Simazine had also been applied on 8 December 1988 to 5.7 ha of winter beans at a rate of 1.15 kg/ha. Results showed a delay of no more than 2 hr between rainfall commencement and entrance of the herbicide into the streams. The magnitude of simazine runoff decreased in the second rainfall event. The mean concentration during the first event was 29.5 micrograms/L and in the second only 8.1 micrograms/L The mass of pesticide accounted for in each of the events was 60.0 g and 0.6 g respectively, compared with a total application of 20.0 kg. This represented 0.3% of the total application for the first event and 0.05% for the second event. (Geiger-PTT) W91-11364

IMPACT OF CARBON DIOXIDE AND AMMONIUM ON THE GROWTH OF SUBMERGED SPHAGNUM CUSPIDATUM.

Katholieke Univ. Nijmegen (Netherlands). Dept. of Aquatic Ecology and Biogeology. For primary bibliographic entry see Field 2H. W91-11452

AGRONOMIC EFFECTS OF LAND APPLICA-TION OF WATER TREATMENT SLUDGES, Pennsylvania State Univ., University Park. Dept.

of Agricultural Engineering. H. A. Elliott, and B. A. Dempsey. Journal of the American Water Works Association JAWWA5, Vol. 83, No. 4, p 126-131, April 1991. 2 tab. 36 ref.

Descriptors: \*Agronomy, \*Environmental effects, \*Land disposal, \*Sludge disposal, \*Wastewater farming, \*Wastewater utilization, Boron, Copper, Fertilizers, Legal aspects, Liming, Manganese, Metals, Molybdenum, Nitrogen, Nutrients, Phosphorus, Sludge utilization, Zinc.

Economic, regulatory, and legal constraints on alternative disposal methods are raising interest in land application of water treatment sludges (WTS). A clear understanding of the agronomic and environmental effects is the first step toward implementing a land-based disposal option that will win regulatory approval and public acceptance. The chemical, physical, and biological characteristics of WTS determine its potential benefits and adverse effects on soil. WTS poses a less serious environmental threat than that posed by sewage sludge. However, aside from the iming capacity of softening sludges, the agronomic benefits of MTS, at least as a fertilizer, are fewer. The agronomic benefits of nitrogen in WTS depend more on its availability than on the total amount present. WTS can potentially correct soil deficiencies of iron and such micronutrients as boron, copper, manganese, zinc, and molybdenum. Phosphorus-fixing properties have been noted in WTS; this reduction in P mobility can be an asset when WTS is applied to soils with a high P pollution potential. Understanding the behavior and fate of metals in WTS-amended soils requires an evaluation of speciation, availability, and mobility. Waste handling methods at the treatment plant significantly affect ultimate disposal. A public relations effort is essential for a successful land application program. It is concluded that health and environmental risks are minimal from properly managed application of WTS to soils. (Doria-PTT)

BUDGETS OF SELECTED CATIONS AND ANIONS IN TWO FORESTED EXPERIMENTAL WATERSHEDS IN CENTRAL GREECE, Forest Research Inst., Athens (Greece).

Forest Research Inst., Athens (Greece). G. Nakos, and A. Vouzaras. Forest Ecology and Management FECMDW, Vol. 24, No. 2, p 85-95, 1988. 3 fig. 7 tab, 13 ref.

Descriptors: \*Land use, \*Forestry, \*Clearcutting, \*Environmental impact, \*Environmental chemistry, \*Forest watersheds, \*Cations, \*Anions, \*Greece, Potassium, Chlorides, Sodium, Sulfates, Nitrates, Nitrites, Ammonia, Calcium, Magnesium, Bicarbonates, Hydrogen ion concentration.

Concentration trends and budgets of selected ions dissolved in stream water were studied over four hydrological years in two forested experimental watersheds of central Greece, where Abies cephalonica was the dominant tree species. Weighted average annual concentrations (mg/L) of selected ions were: Ca(2+), 10.16; Mg(2+), 1.91; K(+), 0.77; Na(+), 4.45; Cl(-), 7.9; SO4(2-), 4.42; NH4(+)-N, 0.44; NO3(-)-N, 0.88; and pH, 7.26. Monthly concentrations of Ca(2+), Mg(2+), Na(2+) and HCO(3-) decreased with increasing rates of stream discharge up to a certain value, and thereafter remained almost constant. To the contrary, concentrations of J(+), Cl(-), SO4(2-), NH4(+)-N, like pH, were independent of rates of stream discharge. A 15% removal of the total standing volume did not change the concentrations, in stream water, of the selected ions. The data suggest that, annually, the experimental watersheds gained about 6 kg/ha or inorganic nitrogen and lost: Ca(2+), 56 kg/ha; Na(+), 34 kg/ha; Cl(-), 33 kg/ha; SO4(2-), 26 kg/ha; Mg(2+), 13 kg/ha; Cl(-), 3 kg/ha, (Author's abstract) W91-11550

DESCRIPTION OF THE PHYSICAL ENVI-RONMENT AND COAL-MINING HISTORY OF WEST-CENTRAL INDIANA, WITH EMPHASIS ON SIX SMALL WATERSHEDS. For primary bibliographic entry see Field 2E.

W91-11576

#### 4D. Watershed Protection

WATERSHED-BASED CONSERVATION PROGRAMS IS THE PUBLIC GETTING ITS MONEY'S WORTH.
Triton Environmental Consultants Ltd., Burnaby

Triton Environmental Consultants Ltd., Burnaby (British Columbia).
For primary bibliographic entry see Field 6C.
W91-11048

CHANNEL AND BANK STABILITY OF WOLF CREEK AND A TRIBUTARY AT U.S. HIGH-WAY 45 NEAR WHEELER, PRENTISS COUNTY, MISSISSIPPI. Geological Survey, Jackson, MS. Water Resources

Geological Survey, Jackson, MS. Water Resources Div. For primary bibliographic entry see Field 2E. W91-11107

NATIONAL PROGRAM FOR SOIL AND WATER CONSERVATION. ITS EFFECT ON USDA SERVICES. For primary bibliographic entry see Field 3F. W91-11169

WATERSHED DEVELOPMENT IN ASIA: STRATEGIES AND TECHNOLOGIES. For primary bibliographic entry see Field 6B. W91-11563

STRATEGIC ISSUES IN WATERSHED DEVEL-

OPMENT.

International Bank for Reconstruction and Development, Washington, DC. Environmental Policy Research Div.

Research Div.

W. B. Magrath, and J. B. Doolette.

IN: Watershed Development in Asia: Strategies and Technologies. World Bank Technical Paper No. 127. World Bank Publications, Washington, DC. 1990. p 1-34, 7 tab, 31 ref.

Descriptors: \*Asia, \*Environmental impact, \*Government supports, \*Water resources development, \*Watershed management, \*Watersheds, Agricultural watersheds, Developing countries, Economic aspects, Economic development, Land development, Management planning, Water resources management.

Land that can be defined as watershed in Asia is a significant proportion of the total land. These watersheds suffer such problems as loss of agricultural productivity due to erosion, deforestation, population pressure and poverty, sedimentation of infrastructure downstream, flooding, and erratic streamflows. The main themes emerging from analyses of watershed problems involve typical policy responses by governments and multilateral and bi-lateral donors, and the insufficient evolution of conservation technology. The rationale for a watershed management approach must be examined in the context of physical, economic, and political linkages, taking into account the interplay between upland and lowland areas. In proposing how investments may be made to solve watershed problems, a case can be made that the most technically and economically efficient approach would focus on site-specific technologies that are environmentally benign. Specific actions that development agencies should pursue in their operations and in discussions with governments include structural treatments, vegetative/cultural measures, investment in nonarable areas, and treatment of forest areas. The problem-solving approach should take into account the folly of a single solution, the importance of planning at a micro level, and a menu of solutions. Incentives for participation in watershed development may include land tenure, profitability of the farming system, and economicatus for the participants. Recommended approaches to watershed development need to address flooding and sediment, cost sharing and cost recovery, rural infrastructure, analytic methods, guidelines, funding procedures, and the need for commitment. (See also W91-11563) (Fish-PTT)

W91-11564

SOIL AND MOISTURE CONSERVATION TECHNOLOGIES: REVIEW OF LITERATURE. International Bank for Reconstruction and Development, Washington, DC. Agriculture Div. J. B. Doolette, and J. W. Smyle. IN: Watershed Development in Asia: Strategies and Technologies. World Bank Technical Paper No. 127. World Bank Publications, Washington, DC. 1990. p 35-69, 6 tab, 221 ref.

Descriptors: \*Agricultural watersheds, \*Asia, \*Literature review, \*Soil conservation, \*Soil water, \*Water conservation, \*Water resources water, water conservation, water resources management, Agricultural engineering, Climatic zones, Developing countries, Erosion, Farm management, Productivity, Sedimentation, Soil treatment, Surface runoff, Water resources develop-

The World Bank has financed many projects with substantial watershed development components. This substantial investment, combined with the Inis substantia investment, combined with the sizable commitment implicit in projects under preparation, prompted regional staff to question the technologies and treatments from the standpoint of efficacy, synergism, the benefits accruing from them, and relative cost and replicability. Research literature has been reviewed concerning onsearch interature has been reviewed concerning on-farm impacts of soil and moisture conservation technologies on surface runoff, erosion/sedimenta-tion and productivity and yield. The review in-cludes data from more than 200 studies globally that appear to be based on valid experimental methods. The literature regarding the impact on soil moisture and surface runoff may be categorized as clearing land for agriculture, vegetative and cultural measures (grass cover and strips, and cultural measures (grass cover and strips, mulching, cultivation practices, contour cultivation, ridge and furrow), and structural measures (earth banks, land leveling, and terraces). The effect of treatments on erosion rates and sediment yields is arranged by climatic zones, e.g., equatorial monsoon, continuously wet tropics, dry/wet monsoon, wet and dry tropics, temperate zone, semi-arid tropics, and semi-arid temperate zone. Causes of productivity decline are soil moisture loss, soil nutrient loss, and organic matter. Soil treatments include cover, clearing of land, tillage, contour cultivation and ridging, vegetative barriers treatments include cover, clearing of land, tillage, contour cultivation and ridging, vegetative barriers on key contour lines, ripped furrows, construction of banks, land leveling, and terracing. There are limitations to extrapolating from the data to other sites and projects, due to lack of standardized methodologies and limited quantitative data. A need is seen for sound results from well-designed and properly equipped experiments, and for expansion of the types and ranges of experiments to cover the extreme situations experiments to cover the extreme situations experienced by small farmers. (See also W91-11563) (Fish-PTT) W91-11565

ECONOMIC ANALYSIS OF SOIL CONSERVA-TION TECHNOLOGIES.

International Bank for Reconstruction and Development, Washington, DC. Environmental Policy

Research Div W. B. Magrath.

In: Watershed Development in Asia: Strategies and Technologies. World Bank Technical Paper No. 127. World Bank Publications, Washington, DC. 1990. p 71-96, 7 fig, 9 tab, 18 ref, 2 append.

Descriptors: \*Agricultural engineering, \*Agricultural runoff, \*Asia, \*Erosion control, \*India, \*Productivity, \*Soil conservation, \*Soil erosion, Cropyield, Developing countries, Earthworks, Economic aspects, Grasses.

It is widely accepted that erosion lowers agricultural productivity and that soil conservation raises and preserves it. However, there is little agreement on exactly how productivity is related to erosion or on the quantitative impact of erosion on yields. Nor is there widespread agreement on how erosion influences the accompany of agricultural productions. Nor is there witespread agreement on now crosson influences the economics of agricultural production. In view of these difficulties, an engineering economics approach is most practical: the impacts of erosion and conservation are applied to an economic model of crop production and the value of

conservation is calculated on the basis of a with-without comparison. The relative economic advantages of a conservation system based on vetiver grass (Vetiveria zizanioides) was explored by comgrass (Vetiveria zizanioides) was explored by comparison with the more conventional approach of constructing earthen bunds, using data reflecting conditions in India. By interrupting the length of the field, both techniques are intended to slow movement of water down the slope; however, vetiver grass hedges eventually form terraces, and earthen bunds are designed to channel surplus water into drains. The results of the basic analysis showed that both systems appear economically viable using base case assumptions. However, due to its speculative nature, modeling of a range of plausible combinations of parameters was performed. It was found that the dominance of vetiver grass technology is essentially complete for any tormed. It was round that the dominance of vertiver grass technology is essentially complete for any plausible combination of parameters, mainly due to the cost advantage of vetiver grass. For instance, vetiver grass with a net present value of Rs 8,543/ha (IRR=95%) is clearly superior to bunding (NPV=Rs 3,436/ha, IRR=28%). It may be concluded that, despite obvious gaps in knowledge, a structured analysis of soil conservation investments. structured analysis of soil conservation investments can generate useful insights, and perhaps most usefully, can highlight specific issues on which additional research is necessary. There is an obvious need for more reliable cost data on crop production and a better understanding, both technical and economic, of farmers' responses to erosion. (See also W91-11563) (Fish-PTT)

ECONOMIC ANALYSIS OF OFF-FARM SOIL

CONSERVATION STRUCTURES.

International Bank for Reconstruction and Development, Washington, DC. Environmental Policy

Nesteated Dev.

B. Magrath.

IN: Watershed Development in Asia: Strategies and Technologies. World Bank Technical Paper No. 127. World Bank Publications, Washington, DC. 1990. p 97-107, 1 fig, 9 tab, 9 ref.

Descriptors: \*Check dams, \*Cost-benefit analysis, \*Economic aspects, \*Hydraulic structures, \*Soil conservation, Developing countries, Economic evaluation, Erosion rates, Hydraulic engineering, Indonesia, Irrigation, Silting.

Although off-farm structures such as check dams Attnough off-arm structures are often a sub-stantial portion of costs in watershed projects, they are seldom subjected to benefit-cost analysis, due to their typically small size and dual objective of providing environmental and productive benefit. A benefit-cost analysis was performed based on data collected in Indonesia for a representative check dam. Regression analyses of average values and construction cost, and sensitivity analyses of ner present values to construction costs were conductconstruction cost, and sensitivity analyses of net present values to construction costs were conduct-ed. It was found that, for all combinations, higher erosion rates (or shorter life spans) yield higher returns, due to the earlier onset of land reclamation benefits. It was concluded that a rudimentary analysis can help distinguish viable investments from unprofitable ones, even when values for environmental benefits are uncertain. Furthermore, the effort required for benefit-cost analysis is minimal, compared to the engineering and construction input. Also noted are some strategic considerations involved in evaluating off-farm structures for watershed projects, such as requiring implementing agencies to include simple economic analysis in the planning of such structural works, and to consider the economic productivity of small structures in relation to cost. (See also W91-11563) (Fish-PTT) W91-11567 mental benefits are uncertain. Furthermore, the

REVEGETATION TECHNOLOGIES.

A. K. Banerjee.

IN: Watershed Development in Asia: Strategies
and Technologies. World Bank Technical Paper
No. 127. World Bank Publications, Washington,
DC. 1990. p 109-129, 1 tab, 16 ref.

Descriptors: \*Asia, \*Erosion control, \*Planting management, \*Rehabilitation, \*Revegetation, \*Soil conservation, \*Vegetation establishment, \*Watershed management, Developing countries, Fences,

Forest management, Grasses, Reforestation, Shrubs, Trees.

Revegetation is a significant technology employed in the rehabilitation of upper watersheds in the Asia region. It traditionally encompasses both enrichment planting and forestation of bare areas. However, much plantation work has been less successful than hoped, due to both technical and nontechnical reasons. A review of available technology reveals a number of shortcomings: choice of secritic has overembasized trees excitics. of species has overemphasized trees, exotics, and monoculture; the introduction of shrubs, indigemonoculture; the introduction of shrubs, indige-nous legumes and grasses, on the contour as a hedge, should find a place in land stabilization and the regeneration of vegetation. Ground prepara-tion includes removal of ground vegetation, win-drowing, burning, and soil manipulation. In plant-ing methods, reintroduction of direct sowing and more use of bare-root planting and biodegradable containers to reduce cost are proposed. In planting design, it is suggested that planting with a shrub hedge on the contour; in between the tree rows hedge on the contour in between the tree rows should replace the present method of square planting. Regarding protection, social consent with watch and ward or with a live hedge raised at least two years in advance is preferable to other forms of fencing. Management of revegetated areas presof fencing. Management of revegetated areas presently comprises two methods: complete protection without any harvesting and regular harvesting at the rotation age. Both methods fail to consider the needs of local villagers for a continuous supply of products. This can be satisfied by introducing silvicultural practices such as annual brashing, low and high pruning and topping of the hedge, and thinning of the top canopy of trees. There is a critical need for active participation by local inhabitants in revegetation programs, which is now often lacking. (See also W91-11568) (Fish-PTT)

LAND TENURE ISSUES IN WATERSHED DE-VELOPMENT. For primary bibliographic entry see Field 6F. W91-11569

FRAMEWORK FOR PLANNING, MONITOR-ING, AND EVALUATING WATERSHED CON-SERVATION PROJECTS.

For primary bibliographic entry see Field 6B. W91-11570

#### 5. WATER QUALITY MANAGEMENT AND PROTECTION

#### 5A. Identification Of Pollutants

MEASUREMENT OF THE EFFECT OF OR-GANIC POLLUTION ON MARINE ORGA-NISMS: RAPID DETERMINATION OF EROD INDUCTION USING PLATE READERS.

Institut Français de Recherche pour l'Exploitation de la Mer, Nantes. Lab. Effets Biologiques des

Nusances.

D. Grzebyk, and F. Galgani.

Aquatic Living Resources ALREEA, Vol. 4, No. 1, p 53-59, 1991. 9 fig, 1 tab, 16 ref.

Descriptors: \*Bioassay, \*Bioindicators, \*Monitoring, \*Testing procedures, \*Water pollution effects, EROD assay, Enzymes, Kinetics, Laboratory methods, Marine environment, Polychlorinated biphenyls, Polycyclic aromatic hydro

Ethoxyresorufin O-deethylase (EROD) is a mixed function oxidase which is supported by induced forms of cytochrome P-450. These isoforms are induced in natural environments by polycyclic aroinduced in natural environments by polycyclic aro-matic hydrocarbons present in petroleum and by polychlorinated biphenyls (PCBs). The EROD assay was adapted to the microplate technique and conditions for optimal measurements were studied in several species useful in a monitoring system. A simplified procedure was developed for the prepa-ration and fluorimetric assay of EROD activity using only basic laboratory equipment. In addition

#### Group 5A-Identification Of Pollutants

to reproducibility of results and a good sensitivity to reproducionity of results and a good sensitivity identical to that of the classical cuvette technique, the greatest advantage to using microplate readers is the rapidity of the measurements. This permits multiple simultaneous assays and thus long kinetic studies which are of interest for measuring low stibilities and avoiding intercrution of the actions of the actions. studies which are of interest for measuring fow activities and avoiding interruption of the acetone reaction. It was possible to automate the technique, distribution of reagents, and processing of data. The method was used to determine EROD activity in plaice, flounder, and eel. The microplate read technique was twice as sensitive as the classic cuvette reader for the EROD activity assay. With the plate reader the coefficient of variation was less than 7%. In the context of biological monitor-ing, especially of PAH and PCBs, the direct ing, especially of PARI and PARI and PEROD activity assay using the microplate reader technique combines the advantages of simplicity and rapidity which are essential to such surveillance projects. (Mertz-PTT) W91-10469

# GROWTH POTENTIALS OF RED TIDE PHY-TOPLANKTERS IN COASTAL SEAWATER BY AGP ASSAY.

Kochi Univ. (Japan). Faculty of Agriculture. T. Nishijima, and Y. Hata. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 175-179, 1991. 3 fig, 7 tab, 5 ref.

Descriptors: \*Algal growth, \*Bioassay, \*Coastal waters, \*Phytoplankton, \*Pollutant identification, waters, \*Phytoplankton, \*Pollutant identification, \*Red tide, Culturing techniques, Japan, Limiting nutrients, Nitrogen, Osaka Bay, Phosphorus.

Preparation of algal inocula for algal growth po-tential (AGP) was investigated. Using two red tide phytoplankters, and growth potentials and growth-limiting nutrients of red tide phytoplankters were evaluated in coastal waters of Osaka Bay, Japan. evaluated in constal waters of Osaka bay, Japan. The red tide phytoplankters Heterosigma akashiwo and Skeletonema costatum were used as assay organisms. When using AGP assays, the growth potentials were dependent on the preparation of the algal inoculum. Accurate growth potentials were obtained only when sufficiently nutrient-starved cells were inoculated into the samples. Insufficient starvation of the cells resulted in an overestimation of growth potential. Based on the overestimation of growth potential. Based on the results of the assay, the growth potentials of Osaka Bay water were about 10,000 cells/ml for Heterosigma akashiwo and about 100,000 cells/ml for Skeletonema costatum. Moreover, the water had the potential to develop to a red tide population density for both species. The limiting nutrients for both red tide phytoplankters were nitrogen and phosphorus. (Author's abstract) W91-10548

# MARINE POLLUTION BIOASSAY BY USING SEA URCHIN EGGS IN THE TANABE BAY, WAKAYAMA PREFECTURE, JAPAN, 1970-1987.

Doshisha Univ., Kyoto (Japan). Biological Lab. N. Kobayashi.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 709-713, 1991. 1 fig, 1 tab, 4 ref.

Descriptors: \*Bioassay, \*Echinoderms, \*Japan, \*Pollutant identification, \*Tanabe Bay, Antifoulants, Bioaccumulation, Juvenile growth stage, Marine pollution, Mortality, Organotin compounds, Seasonal variation.

The results of eighteen years of bioassays of the water at the Seto Marine Biological Laboratory and around Hatakejima Island, Shirahama, and Wakayame Prefecture, are reported. Eggs and sperm of Hemicentrotus pulcherrimus and Pseudosperm of Hemicentrotus pulcherrimus and Pseudo-centrotus depressus were used as bioassay orga-nisms. During 1982 and 1987, very polluted water was found around Hatakejima Island and Tsuna-shirazu Cove in early autumn to winter. As these phenomena differed from the tendency of polluted water to occur mainly in summer, the cause was, most probably, tributyltin oxide, a biocide used in the paint on the fish rearing cages in the area. (Brunone-PTT) W91-10602

HEALTH-RELATED WATER MICROBIOLO-

GY 1990. For primary bibliographic entry see Field 5F. W91-10612

MICROBIOLOGICAL METHODS FOR SAFETY TESTING OF DRINKING WATER DI-RECTLY RECLAIMED FROM WASTEWATER. Pretoria Univ. (South Africa). Dept. of Medical

Wirology. W. O. K. Grabow, R. Kfir, and J. L. Slabbert.
Water Science and Technology WSTED4, Vol.
24, No. 2, p 1-4, 1991. 15 ref.

Descriptors: \*Bioassay, \*Bioindicators, \*Drinking water, \*Microbiological studies, \*Pollutant identification, \*Toxicity, \*Wastewater renovation, \*Water quality monitoring, \*Water reuse, Ames test, Bacteria, Bacteriophage, Carcinogenicity, Chemical analysis, Coliforms, Culturing techniques, Enzymes, Epidemiology, Growth media, Mutagenicity, Namibia, Performance evaluation, Pseudomonas, Salmonella.

Microbiological methods were assessed for the testing of drinking water directly reclaimed from wastewater at an advanced multiple-barrier reclamation system in Namibia. The safety of the water could be monitored reliably by such practical indi-cators as standard plate counts, coliform bacteria, coliphages, and acid-fast bacteria. A convenient plate incorporation modification of the Ames Salmonella mutagenicity assay proved suitable for routine quality surveillance of potentially carcino-genic and mutagenic compounds; results were con-firmed by comparative tests using a hamster em-bryonic cell transformation assay in which sensitivoryonic cell transformation assay in which sensitivity was increased by preparing growth media from test water. Screening for toxic activity was done reliably by assays based on interference with the multiplication of Pseudomonas putida, the cloning efficiency of BGM, HeLa, and mouse lymphoma cell lines and activity of the enzyme urgase. A cell lines, and activity of the enzyme urease. A commercial limulus amebocyte lysate assay proved a reliable and sensitive method for the detection of endotoxins. Correlation with results obtained in sophisticated chemical analyses, as well as long-term epidemiological studies on consumers, conterm epidemiological studies on consumers, con-firmed that, subject to the maintenance of certain operational conditions, the safety of directly re-claimed water could be monitored by relatively simple, inexpensive, and rapid microbiological tests and bioassays. (See also W91-10612) (Author's abstract) W91-10613

#### EC BATHING WATER VIROLOGICAL STAND-ARD: IS IT REALISTIC.

Severn-Trent Labs., Coventry (England). Water Science and Technology WSTED4, Vol. 24, No. 2, p 49-52, 1991. 3 tab, 3 ref.

Descriptors: \*Europe, \*European Economic Community, \*Public health, \*Recreation, \*Swimming, \*Viruses, \*Water analysis, \*Water pollution management, \*Water quality monitoring, \*Water qualagement, water quanty monitoring, water quarty ity standards, Analytical techniques, Bacteria, Bioindicators, Contamination, Enteroviruses, Human diseases, International agreements, Pathogens, Sampling, Standards, Wastewater.

The European Community (EC) directive on bathing water defines a viral standard of nil in 10 liters but does not recommend the means by which viruses should be concentrated and detected. The viruses should be concentrated and detected. In edirective's standard for viruses is mandatory, requiring a 95% compliance level in the waters during the bathing season. As yet no virological monitoring is carried out in such a way as to comply with the 95% pass rate required by the directive. While viruses can be detected in any waters that receive sewage discharges, there is growing evidence that the use of the bacterial indicator system to indicate health risk and virus presence is faulty. Virus methodologies are currently limited to the determination of culturable renty inflined to the determination of culturable enteroviruses and rotavirus. There are no methods for the known waterborne pathogens such as hepatitis A and Norwalk-type viruses. This does not allow for the assay of total virus content, the

present zero standard for enteroviruses thus being only a likely minimum measure of virus contamina-tion. One possibility for altering the standard is to reduce the implied compliance level of 95% to 80%, which would give a virus sample in each month of the (British) bathing season of May to September. Another possibility is to categorize waters according to the type of recreation that would be acceptable in terms of exposure to vi-ruses. Until there is clear evidence to indicate that the risk is at least acceptable for the recreational activity proposed, the EC standard should remain. (See also W91-10612) (Doria-PTT) W91-10622

# PRODUCTION AND CONTROL OF REFERENCE MATERIALS FOR WATER MICROBI-

Rijksinstituut voor de Volksgezondheid en Milieu-hygiene, Bilthoven (Netherlands). Lab. for Water

hygiene, Buthoven (vecineriands). Lab. 10 Mars and Food Microbiology. K. A. Mooijman, A. H. Havelaar, J. A. Hoekstra, and N. G. W. N. van Strijp-Lockefeer. Water Science and Technology WSTED4, Vol. 24, No. 2, p 53-56, 1991. 4 fig, 2 ref.

Descriptors: \*Analytical methods, \*Bacterial analysis, \*Public health, \*Quality control, \*Standards, \*Water analysis, \*Water pollution management, \*Water quality monitoring, Bacteria, Enterobacter, Escherichia coli, Microbiological studies, Milk, Optimization, Sample preservation, Staphylocochiz cus. Temperature.

The use of standard methods for microbiological analysis of water does not guarantee consistent results in different laboratories. Therefore, reference materials for water microbiology were pre-pared by spray-drying milk artificially contaminated with a known test strain. The resulting highly contaminated milk powder was mixed with sterile milk powder to a contamination level of 2,000-3,000 cfu/g. Gelatin capsules were filled with the mixture (0.2 g/capsule) to produce the reference materials. Test strains used were: WR1 Escherichia coli, WR3 Enterobacter cloacae, WR63 Enterocon, wks Enteropacter cloacae, wkos Entero-coccus faecium, and WR51 Staphylococcus sp. Optimization of the mixing procedure and aging of the highly contaminated milk powder for at least one year resulted in relatively homogeneous and stable reference materials. Short-term challenge tests at 'high' temperatures (30 and 37 C) may be tests at 'nign' temperatures (30 and 37 C) may be predictive for long-term stability at 'low' temperatures (4 to 6 C). Reference materials with strain WR3 were stable for one week at 30 C and for at least 6 months at 4 to 6 C. Possible applications of the reference materials include quality control of routine measurements, comparison of the efficiency of different culturing methods, and as a standardized sample in collaborative studies. (See also W91-10612) (Doria-PTT) W91-10623

PRELIMINARY STATISTICAL ASSESSMENT OF UK WATER QUALITY CONTROL TRIALS. Central Public Health Lab., London (England). Communicable Disease Surveillance Centre. For primary bibliographic entry see Field 5G.

SURVEILLANCE SOLUTIONS TO MICROBIO-LOGICAL PROBLEMS IN WATER QUALITY CONTROL IN DEVELOPING COUNTRIES. For primary bibliographic entry see Field 5G. W91-10625

EVALUATION OF FECAL ENTEROCOCCI ISOLATION MEDIA TO INDICATE FECAL POLLUTION IN CHLORINATED WATER. Rand Water Board, Johannesburg (South Africa). For primary bibliographic entry see Field 5F. W91-10626

COLIFORM BACTERIA IN DRINKING WATER FROM SOUTH BAVARIA: IDENTIFICATION BY THE API 20E-SYSTEM AND RESISTANCE PATTERNS.

#### Identification Of Pollutants-Group 5A

Landesuntersuchungsamt fuer das Gesundheitswesen Suedbayern, Munich (Germany, F.R.). For primary bibliographic entry see Field 5F. W91-10627

EFFECT OF HEAT SHOCK ON RECOVERY OF ESCHERICHIA COLI FROM DRINKING WATER.

Robens Inst. of Industrial and Environmental Health and Safety, Guildford (England). For primary bibliographic entry see Field 5F. W91-10628

BACTERIOLOGICAL SUITABILITY OF WATER FROM BASRAH WELLS FOR DRINK-

Basrah Univ. (Iraq). Dept. of Biology.
A. A. Al-Sulami, and H. A. Yaseen.
Water Science and Technology WSTED4, Vol.
24, No. 2, p 89-93, 1991. 6 tab, 14 ref.

Descriptors: \*Bacterial analysis, \*Drinking water, \*Iraq, \*Pollutant identification, \*Water analysis, \*Water quality monitoring, \*Well water, Aerobic bacteria, Bacteria, Basrah, Biochemical oxygen demand, Chlorides, Coliforms, Culturing techniques, Dissolved oxygen, Fecal bacteria, Filtration, Heterotrophic bacteria, Hydrogen ion concentration, Temperature, Water pollution sources.

A survey of heterotrophic aerobic bacteria, total coliforms, fecal coliforms, and fecal streptococci was performed on water samples from 32 wells in the desert west of Basrah (Iraq). Physical and chemical parameters were as follows: temperature 26-28 C; pH 7-8.4; and dissolved oxygen 3.7-5 mg/L. Correlation coefficient values between total viable count (TVC) and physical or chemical parameters suggested that TVC was not correlated with any environmental variables tested. Fecal contamination of wells was mostly of animal sources as indicated by the low ratio of fecal coliforms to fecal streptococci. Four methods were used to enumerate the bacteria: spreading, membrane filtration, repair detection, and replica plating. The last method was most accurate, especially for detecting injured cells. Fecal coliforms ranged ing. Ine last method was most accurate, especially for detecting injured cells. Fecal coliforms ranged from 5 to 280 cfu/ml. Biochemical oxygen demand of the well water was 0.6-1.5 mg/L, and chloride content of wells was 354-1,240 mg/L. It is concluded that Basrah well water should be purified before drinking. (See also W91-10612) (Doria-PTT) W91-10629

RELATIONSHIP BETWEEN PSEUDOMONAS AERUGINOSA AND BACTERIAL INDICA-TORS IN POLLUTED NATURAL WATERS.

Malaga Univ. (Spain). Facultad de Ciencias. A. de Vicente, J. C. Codina, and P. Romero. Water Science and Technology WSTED4, Vol. 24, No. 2, p 121-124, 1991. 1 fig, 2 tab, 12 ref.

Descriptors: \*Bacterial analysis, \*Bioindicators, \*Path of pollutants, \*Pseudomonas, \*Water quality monitoring, Bacteria, Fecal coliforms, Fecal strep-tococci, Malaga, Rivers, Seawater, Spain, Wastewater, Water pollution, Water pollution

The relationship was established between Pseudomonas aeruginosa and the fecal pollution index (total coliforms, fecal coliforms, and fecal strepto-cocci) in natural waters. Water samples were collected from several aquatic environments in Malaga (Spain). Pseudomonas aeruginosa counts Malaga (spain). Fseudomonas aeruginosa counis and isolation frequencies were clearly associated with the degree of fecal pollution of the water. Results confirmed that domestic sewage was the major source of P. aeruginosa in river water and seawater, being isolated from sewage at concentrations of about 100,000 cfu/100 ml. There was a close correlation between the P. aeruginosa con-centration and the densities of the three fecal indicators in both river and marine waters. A significant correlation was not observed in waters with little fecal pollution, because P. aeruginosa was isoleted from these materials. isolated from these waters only occasionally and at very low densities. Pseudomonas aeruginosa con-centrations in sewage and polluted natural waters were generally 3-4 log lower than the total coliform (TC) densities and 2 log lower than fecal coliform (FC) and fecal streptococci (FS) concentrations. TC, FC, and FS could be considered adequate indicators of the presence and densities of P. aeruginosa in natural waters, especially TC in fresh water and FS in seawater, as these parameters showed the best correlations and the most parallel inactivation processes with P. aeruginosa in each environment. (See also W91-10612) (Author's abstract)

PROTECTIVE EFFECT OF GLYCINE BETA-INE ON SURVIVAL OF ESCHERICHIA COLI CELLS IN MARINE ENVIRONMENTS,

Institut National de la Sante et de la Recherche Medicale, Nice (France). Unite 303 Mer et Sante. For primary bibliographic entry see Field 5B. W91-10637

EFFECT OF DISSOLVED NUTRIENTS AND INORGANIC SUSPENDED SOLIDS ON THE SURVIVAL OF E. COLI IN SEAWATER. Clyde River Purification Board, East Kilbride

(Scotland). For primary bibliographic entry see Field 5B. W91-10638

MINIATURIZED FLUOROGENIC ASSAYS FOR ENUMERATION OF E. COLI AND EN-TEROCOCCI IN MARINE WATER. Institut Pasteur de Lille, Villeneuve d'Ascq

J. F. Hernandez, J. M. Guibert, J. M. Delattre, C.

Oger, and C. Charriere. Water Science and Technology WSTED4, Vol. 24, No. 2, p 137-141, 1991. 6 tab, 7 ref.

Descriptors: \*Bacterial analysis, \*Bioindicators, \*Culturing techniques, \*Enteric bacteria, \*Escherichia coli, \*Fluorescence, \*Pollutant identification, \*Water quality monitoring, Bacteria, Culture media, English Channel, Fecal bacteria, Filtration,

A miniaturized fluorogenic assay was developed as a rapid and easy procedure for the enumeration of fecal indicators in seawater. To detect Escherichia fecal indicators in seawater. To detect Escherichia coli, 4-methylumbelliferyl beta-D-glucuronide (MUG) was incorporated into a modified Al broth. To detect enterococci, 4-methylumbelliferyl broth. To detect enterococci, 4-methylumbelliferyl beta-D-glucoside (MUD) was incorporated into a selective medium. To each well of a sterile 96-well microtitration plate, 100 microL of media was added, air-dried, covered with sterile tape, and stored at 4 C. To enumerate the indicator bacteria, 200 microL of diluted or undiluted water was added to wells with MUG and MUD media. The plates were incubated for 36-40 hours at 44 C and observed in the dark for fluorescence by ultraviolation of the control of the subsurface margine, water better the control of the subsurface margine, water better the control of the cont let light (366 nm). Fifty subsurface marine waters from four areas were examined. The recovery rate from four areas were examined. The recovery rate of the fluorogenic assays is equal or superior to 3-tubes must probable number (MPN) and membrane filtration (MF). The microtitration plate with MUG is more specific for E. coli than the membrane filtration. An 87.4% confirmation rate was ved with the fluorogenic assay compared to a 6 false-positive rate with membranes. For the observed with the fluorogenic assay compared to a 31.7% false-positive rate with membranes. For the enterococci, the analysis of 23 English Channel and North Sea samples indicated that the fluorogenic assay and the standard methods had the same specificity. In contrast, the microtitration plate with MUD showed by far the best specificity on 13 Mediterranean samples. A 100% confirmation rate was observed with the fluorogenic assay, while 44% and 63% false-positive rates were observed with 3 tubes MPN and MF respectively. (See also W91-10612) (Author's abstract) W91-10612) (Author's abstract) W91-10639

MOST PROBABLE NUMBER METHOD FOR THE ENUMERATION OF LEGIONELLA BAC-

THE ENUMERATION OF LEGISLESS SILVENTE AND TERRIA IN WATER.

Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology.

N. A. Grabow, R. Kfir, and W. O. K. Grabow.

Water Science and Technology WSTED4, Vol.

24, No. 2, p 143-147, 1991. 2 tab, 25 ref.

Descriptors: \*Bacterial analysis, \*Culturing techniques, \*Legionella, \*Most probable number test, \*Pathogenic bacteria, \*Pollutant identification, \*Water analysis, Agars, Bacteria, Coliforms, Filtration, Fluorescence, Incubation, Membrane process-

A new quantitative method was developed for the enumeration of Legionella bacteria. Appropriate tenfold serial dilutions of water samples concentrated by membrane filtration are plated in triplicate on buffered charcoal yeast extract agar. After incubation for 3 days, representative smears from individual plates are tested for the presence of Legionella by direct fluorescent antibody (DFA) staining. The number of positive plates in each dilution is used to calculate the Legionella count by means of conventional most probable number statistics. In comparative tests on a variety of by means of conventional most probable number statistics. In comparative tests on a variety of water samples, the new method yielded significantly more positive results than the previously used method. A typical example is a series of 18 comparative tests on mine service waters that were of poor quality on the basis of heterotrophic plate and coliform counts. DFA staining tests on the original concentrates yielded positive results for all the samples. Fifteen of these samples (83%) yielded positive results by the new method, while legionellae were detected in only five (28%) of the samples using the old method. Apart from recovering more Legionella bacteria and yielding higher counts, the new method is quantitative and is less expensive, cumbersome, and time-consuming, yielding results in 3 instead of 14 days. (See also W91-10612) (Doria-PTT) W91-10640

ISOLATION AND IDENTIFICATION OF CRYPTOSPORIDIUM FROM WATER.

Thames Water Authority, London (England). G. Vesey, and J. Slade. Water Science and Technology WSTED4, Vol. 24, No. 2, p 165-167, 1991. 2 fig, 6 ref.

Descriptors: \*Cryptosporidium, \*Isolation, \*Parasites, \*Pollutant identification, \*Protozoa, \*Public health, Centrifugation, Filters, Filtration, Flocculation, Immunoassay, Membranes, Microscopy, Performance evaluation, Water analysis.

The efficiency of the established method for isolation and identification of Cryptosporidium was assessed. Detection of oocysts in water relies upon filtration of large volumes of water and examination of the concentrate by microscopy. An immunofluorescent assay using monoclonal antibodies specific to the outer wall of the cocysts is applied to the concentrate which is then examined with to the concentrate, which is then examined with an epifluorescent microscope. Recovery by these methods was found to be as low as one percent. Each stage of the process was studied to determine where the loss of oocysts occurs. It was found that where the loss of occysts occurs. It was found that between 5 and 30 percent of the occysts were not retained by the initial cartridge filtration. A further 2 to 30 percent could not be eluted. Subsequent stages involving centrifugation and ultrasonic disstages involving centrifugation and ultrasonic disaggregation were shown to disrupt staining by the established immunofluorescence assay; the epitopes to which the monoclonal antibodies are specific appear to be damaged by the shear forces generated during centrifugation. It is concluded that the established method vastly underestimates the number of Cryptosporidium occysts in water. The microwynd filters currently used do not appear to be as effective as previously reported. Intital results using various pleated membranes have been promising. An alternative to centrifugation is obviously required. Investigations into a flocculation ously required. Investigations into a flocculation technique to concentrate samples are in progress. (See also W91-10612) (Doria-PTT) W91-10644

OCCURRENCE OF CRYPTOSPORIDIUM SPP.
OOCYSTS IN SCOTTISH WATERS, AND THE
DEVELOPMENT OF A FLUOROGENIC VIABILITY ASSAY FOR INDIVIDUAL CRYPTOSPORIDIUM OOCYSTS.
Scottish Parasite Diagnostic Lab., Glasgow.

#### Group 5A-Identification Of Pollutants

For primary bibliographic entry see Field 5B. W91-10645

DETERMINING GIARDIASIS PREVALENCE BY EXAMINATION OF SEWAGE, Environmental Monitoring Systems Lab., Cincin-

W. Jakubowski, J. L. Sykora, C. A. Sorber, L. W.

W. Jakudowski, J. L. Sykora, C. A. Sorber, L. W. Casson, and P. D. Gavaghan.
Water Science and Technology WSTED4, Vol. 24, No. 2, p 173-178, 1991. 3 fig, 4 tab, 10 ref.

Descriptors: \*Epidemiology, \*Giardia, \*Human diseases, \*Path of pollutants, \*Pollutant identification, \*Protozoa, \*Public health, \*Wastewater analysis, Cysts, Monitoring, Parasites, Statistical analysis, Wastewater facilities.

Raw sewage samples were collected monthly for one year from 11 wastewater treatment plants across the United States. Giardia cyst concentraacross the United States. Giardia cyst concentra-tions were determined by direct count and the data adjusted based on percentage of industrial wastewater processed by each plant. Although dif-ferences in the adjusted annual geometric mean cyst concentrations were noted among the sites (range 683-3,750 cysts/L), there was no correlation of cyst concentration with geographical location as determined by either latitude or longitude. However, when the three southermost sites were grouped and compared to all remaining sites, there was a significant difference in the annual geometric mean cyst concentration, with the southermost sites being higher. There was no significant association of geometric mean cyst concentration with size of the wastewater treatment plant as represented by mean daily flow. Attempts were made to obtain and correlate giardiasis cases with the monthly cyst levels at each of the sites. Due to reporting problems, low number of cases, and unavailability of data, case information was deemed usable for only four sites. A significant positive correlation with cases in the community was found at one site. Lack of correlation at other sites was believed to be due to deficiencies in case reporting. Results suggest that sewage examination may be useful for surveillance of Giardia infections in the community. (See also W91-10612) (Author's abstract) W91-10646

OCCURRENCE AND VIABILITY OF GIARDIA SPP. CYSTS IN UK WATERS.

Scottish Parasite Diagnostic Lab., Glasgow. For primary bibliographic entry see Field 5B.

REVIEW OF THE EPIDEMIOLOGY AND DI-AGNOSIS OF WATERBORNE VIRAL INFEC-

Institute of Child Health, London (England).

Dept. of Virology.
For primary bibliographic entry see Field 5B.
W91-10651

IMPROVEMENT OF THE ZETA-PLUS FILTER METHOD FOR CONCENTRATION OF VI-RUSES FROM WATER. Tokyo Metropolitan Research Lab. of Public

Health (Japan). K. Yano, Y. Yoshida, and M. Kaneko.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 217-220, 1991. 6 tab, 6 ref.

Descriptors: \*Filtration, \*Japan, \*Pollutant identification, \*Sampling, \*Viruses, \*Water analysis, Anions, Cellulose, Drinking water, Performance evaluation, Preconcentration, Rivers, Sample prep-

Factors affecting the condensation of viruses from river water by zeta-plus filters were studied with the aim of improving the virus detection method. Samples were taken from rivers in Tokyo (Japan). Samples were taken from rivers in Tokyo (Japan). Supplementation of anion-charged diethylaminoethyl-cellulose was used to promote the adsorption of viruses onto the filter. Maximum recovery rate (54.0%) was obtained with a virus concentration of 5,390 pfu/ml, DEAE-cellulose of 0.5%, and

a sample volume of 1,000 ml. The minimum recovery rate (11.4%) was obtained with a virus concentration of 53 pfu/ml, DEAE-cellulose of 0%, and a tration of 35 ptm/ml, DEAE-cellulose of 0%, and a sample volume of 1,000 ml. Addition of cellulose to the water to give a concentration 0.5% resulted in an increase of 21.59% in the recovery rate. The DEAE-cellulose may react with substances in water that disturb the adsorption of viruses; therefore, supplementation with cellulose is unnecessary when the filter method is applied to 'clean' (e.g., finished) waters. (See also W91-10612) (Doria-PTT) W91-10655

ROTAVIRUS DETECTION: A PROBLEM THAT NEEDS CONCENTRATION. Thames Water Authority, London (England).

National Technology WSTED4, Vol. 24, No. 2, p 221-223, 1991. 6 ref.

Descriptors: \*Flocculation, \*Immunoassay, \*Pol-lutant identification, \*Rotaviruses, \*Sample prepa-ration, \*Sampling, \*Ultrafiltration, \*Viruses, \*Water analysis, Adsorption, Comparison studies, Fluorescence, Preconcentration, Shear, Sugars.

Three candidate second-step concentration methods were assessed for the routine detection of rotavirus: organic flocculation, ultrafiltration, and hydroextraction. Virus recovery from each of the methods was quantified by an immunofluorescence methods was quantified by an immunofluorescence assay. After initial adsorption of virus onto a nitro-cellulose filter and subsequent elution with 3% beef broth, organic flocculation gave an average recovery of 4%. Ultrafiltration gave an average recovery of 48%, while hydroextraction in crystalline sucrose gave a recovery rate of 60%. Results suggest that hydroextraction with crystalline sucrose is a very efficient method for the concentration of rotavirus compared to the creamic flocculation of rotavirus compared to the organic flocculation method. Ultrafiltration also showed prom results, although possible disadvantages may be the development of shearing forces and blockage of the filter. Routine detection of rotavirus by the hydroextraction method would produce a result in 3 days; ultrafiltration would give a result in 2 days, but with decreased sensitivity. Possible disadvan-tages of hydroextraction would be aggregation of viruses and the retention of toxic compounds. (See also W91-10612) (Doria-PTT) W91-10656

RECOVERY OF ENTEROVIRUS FROM PRI-MARY SLUDGE USING THREE ELUTION CONCENTRATION PROCEDURES.

Nancy-1 Univ. (France). Faculte de Pharmacie. M. Albert, and L. Schwartzbrod. Water Science and Technology WSTED4, Vol. 24, No. 2, p 225-228, 1991. I fig, I tab, 9 ref.

Descriptors: \*Enteroviruses. \*Pollutant identification, \*Sludge analysis, \*Viruses, Adsorption, Floc-culation, France, Nancy, Preconcentration, Sample preparation, Water analysis

Recovery virus from sewage sludge is usually per-formed by elution of adsorbed virus with an alkaline solution, followed by concentration, before inoculation on cell cultures. Three extraction-concentration procedures were compared using 40-g pellets of solid-fraction sludge prepared from liquid primary sludge from the wastewater treat-ment plant at Nancy (France). Concentrates were ment plant at Nancy (France). Concentrates were assayed using the agar overlay plaque formation technique with inoculation of MA 104 continuous cell line. The highest virus recovery was obtained by elution with 3% beef extract/0.1 M borate buffer at pH 9 together with polyethyleneglycol precipitation as a concentration step. Heterogene-ous and lower results were obtained with elution by a 1% skim milk solution (pH9) or a 0.05 M glycine solution (pH 9) and concentration by organic flocculation. (See also W91-10612) (Doriaganic PTT) W91-10657

CONCENTRATION OF HEPATITIS A VIRUS IN ENVIRONMENTAL SAMPLES, Barcelona Univ. (Spain). Dept. of Microbiology.

A. Bosch, R. Gajardo, F. X. Abad, J. M. Diez, and J. Jofre. Water Science and Technology WSTED4, Vol. 24, No. 2, p 229-234, 1991. 5 tab, 12 ref.

Descriptors: \*Hepatitis A virus, \*Pollutant identification, \*Sample preparation, \*Sampling, \*Viruses, \*Wastewater analysis, \*Water analysis, Adsorp-tion, Assay, DNA, Drinking water, Filters, Floc-culation, Freshwater, Human diseases, Preconcentration. Seawater.

The cytopathogenic pHM-175 strain of hepatitis A virus (HAV) was used to develop different procedures for the concentration of HAV in tap water, fresh water, seawater, and raw sewage. HAV was quantified by a plaque assay in the FRhK-4 cell line. Water samples were concentrated by a modification of the adsorption to and elution from the glass powder (GPAE) method, by adsorption to and elution from filter aid, and by ammonium sulfate flocculation (ASF). The GPAE method consistently yielded greater HAV recoveries than filtration through filter aid or ASF. HAV was concentrated by GPAE from 20-liter samples with satisfactory efficiencies in all kinds of water: 100% for tap water, 80% for freshwater, 75% for seawater, and 61% for sewage. Concentration efficiencies for filter aid and ASF were always lower than 25% and 40%, respectively, in any kind of The cytopathogenic pHM-175 strain of hepatitis A than 25% and 40%, respectively, in any kind of than 25% and 40%, respectively, in any kind of water. The charge of glass powder was modified by polyethylenimine treatment. Concentration efficiencies of HAV in 20-L samples through adsorption to and elution from positively charged glass powder (PGPAE) were 100% for tap water, 94% for seawater, and 61% for freshwater and sewage. The presence of wild-type HAV in sewage samples could be monitored by molecular hybridization with cDNA probes after GPAE concentration. (See also W91-10612) (Author's abstract) W91-10652 W91-10658

ADSORPTION OF VIRUSES BY DIATOMA-CEOUS EARTH COATED WITH METALLIC OXIDES AND METALLIC PEROXIDES.

Florida Univ., Gainesville. Dept. of Microbiology and Cell Science.

S. R. Farrah, and D. R. Preston. Water Science and Technology WSTED4, Vol. 24, No. 2, p 235-240, 1991. 3 tab, 13 ref.

Descriptors: \*Adsorption, \*Diatomaceous earth, \*Filters, \*Oxides, \*Viruses, \*Water analysis, \*Water treatment, Aluminum, Bacteriophage, Cal-cium, Hydrogen ion concentration, Iron, Magnesi-um, Manganese, Water quality monitoring.

It is possible to modify negatively charged micro-porous filters and other solids to increase their ability to adsorb viruses at pH 7 or higher. The production of, and virus adsorption by, diatomaceous earth coated with several metallic oxides was investigated. Untreated diatomaceous earth adsorbed less than 20% of phage MS2 or polio I at pH 7. Diatomaceous earth coated with oxides of aluminum, calcium, iron, magnesium, or manga-nese adsorbed, on average, 97% of MS2 and 98% of polio 1 under the same conditions. Diatomacouse arth coated with manganes oxide adsorbed more than 99% of MS2 and polio 1 at pH 9. Diatomaceous earth coated with ferric oxide adsorbed less than 30% of MS2 and less than 4% of polio 1. Filters containing diatomaceous earth coated with magnesium peroxide adsorbed 83% to 98% of test viruses in water at pH 8.6 even after 100 L had been filtered. Filters made with solids coated with magnesium peroxide may prove useful in removing viruses from treated water or in recovering viruses from water as part of monitoring covering viruses from water as part of monitoring procedures. Coatings of magnesium peroxide are relatively stable and capable of adsorbing viruses in water even after passage of 100 L of water through 3.5 g of coated diatomaccous earth. The more rapid inactivation of bacteria than of viruses on filters. containing magnesium peroxide may filters containing magnesium peroxide may prove useful in reducing bacterial contamination of eluates of filters that are used to recover viruses from natural environments. (See also W91-10612) W91-10659

# Identification Of Pollutants-Group 5A

DETECTION OF ROTAVIRUS IN SOUTH AF-RICAN WATERS: A COMPARISON OF A CY-TOIMMUNOLABELLING TECHNIQUE WITH COMMERCIALLY AVAILABLE IMMUNOAS-

Council for Scientific and Industrial Research, Pre-toria (South Africa). Div. of Water Technology. B. Genthe, G. K. Idema, R. Kfir, and W. O. K.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 241-244, 1991. 2 fig, 1 tab, 10 ref.

Descriptors: \*Immunoassay, \*Pollutant identifica-tion, \*Rotaviruses, \*South Africa, \*Viruses, \*Water analysis, Comparison studies, Enzymes, Freshwater, Seawater, Ultrafiltration, Wastewater.

A cytoimmunolabelling technique was compared with commercially available immunoassays for the detection of simian rotavirus SA11 and human rotavirus in various environmental samples. The rotavirus in various environmental samples. The technique is based on labelling MA104 cells with antibody conjugated with an enzyme for the detection of rotavirus. Water samples were concentrated by ultrafiltration and inoculated on trypsin-treated MA104 cells. After 18 h incubation, evidence of wirel replication was determined by impunolabell. MA 104 cells. After 18 h incubation, evicence or viral replication was determined by immunolabelling of viral antigen using antibodies tagged with horseradish peroxidase. The cytoimmunolabelling method was 100,000 more sensitive for the detection of rotavirus than commercially available enzyme-linked immunosorbent assay (ELISA) and enzyme-instea immunosoroeni assay (ELSA) and latex agglutination kits. The cytoimmunolabelling technique was also successfully detected human rotavirus in river and marine waters and wastewater effluents. The method, which is based wastewater efficients. The includy, winch is based on the detection of early viral replication, is unique for its specificity to detect infectious virus. The incidences in which no viruses were detected by the cytoimmunolabelling method but were detectthe cytoimmunolabelling method but were detected by ELISA might be attributed to the fact that ELISA and the latex agglutination methods detect viral antigen whether the viral particles are infectional methods detect the viral particles are infection. viral antigen whether the viral particles are infectious or not. Another possibility is false positive reactions using ELISA. The determination of infectivity and the increased sensitivity make the cytoimmunolabelling technique the method of choice for detecting rotavirus in environmental water samples. (See also W91-10612) (Doria-PTT) W91-10660

DIFFICULTY OF USING COLIPHAGES AS INDICATORS' AND INDEX' ORGANISMS. Tuebingen Univ. (Germany, F.R.). Hygiene Inst. M. Karst, R. Dutkiewicz, T. Hahn, and K.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 245-250, 1991. 6 fig, 12 ref.

Descriptors: \*Bacteriophage, \*Bioindicators, \*Coliphages, \*Pollutant identification, \*Viruses, \*Water analysis, \*Water quality monitoring, Detergents, Drinking water, Enteric viruses, Filtration, Flocculation, Regulations, Sample preparation,

Concentrating methods for coliphages were investigated. In experiments with seeded tap water, more T-coliphages were recovered by flocculation than by filtration. Although there was only a slight difference between flocculation and filtration in the recovery of MS2 and phi-X174 phage, recovrecovery of these phages was generally greater than that of T-phages. Filtration was slightly superior for coliphages from environmental samples. Recovery with floculation as a whole was 70% or more but fluctuated between 50% and 70% with filtration techniques. There was a major drop in recovery with flocculation and filtration when the anionic detergent Marlon A was present in concentrations of 100 mg/L or more. Nonionic detergents had of 100 mg/L or more. Nonionic detergents had little or no influence even in concentrations of 100 mg/L. For both detergents the concentration of 100 mg/L is 500 times the maximum allowed by German drinking water ordinances. Various difficulties make coliphages impractical as index organisms, or even as indicators, especially in a direct plaque assay in which half of the medium (the sample) cannot be standardized. Furthermore, coliphages are different from enteric viruses in transportation and inactivation behavior, so that colip portation and inactivation behavior, so that coli-phages may be detectable in one aquifer but not

another. It is concluded that coliphages are probably useful only as indicators in a strictly defined system. (See also W91-10612) (Doria-PTT) W91-10661

OCCURRENCE OF MALE-SPECIFIC AND SO-MATIC BACTERIOPHAGES IN POLLUTED SOUTH AFRICAN WATERS.

Council for Scientific and Industrial Research, Pre-toria (South Africa). Div. of Water Technology. For primary bibliographic entry see Field 5B. W91-10662

POLYVALENT COLIPHAGES IN SEWAGE. Bahrain Univ., Manama. Dept. of Biology. M. A. Qureshi, and A. A. Qureshi. Water Science and Technology WSTED4, Vol. 24, No. 2, p 255-259, 1991. 3 tab, 15 ref.

Descriptors: \*Bacteriophage, \*Biocontrol, \*Bioindicators, \*Coliphages, \*Fecal coliforms, \*Viruses, \*Wastewater treatment, Bahrain, Culturing techniques, DNA, Escherichia coli, Genetics, Infection, Isolation, Seasonal variation, Shigella, Temperature, Temperature effects.

The isolation and preliminary characterization of some polyvalent coliphages multiplying in raw sewage in Bahrain (Persian Gulf) was determined. These polyvalent phage may be useful for the biological control of overwhelming populations of fecal coliforms found in raw sewage prior to treatment. Escherichia coli B overnight cultures and fresh two hours log-phase cultures were used for isolation and plaque assay of sewage coliphages. Enumeration of phage was carried out on E. coli By an agar overlay technique. High concentrations of coliphage were isolated during December and March, when the maximum average daytime temperature reaches 20 C. Eight coliphages capable of infecting various strains of E. coli and a few selected enterobacters were isolated. Although all polyed enterobacters were isolated. Although all poly-valent phages contained DNA, they showed variavalent phages contained DNA, they showed varia-tion in plaque size and heat sensitivity. Data clearly confirm the isolation of 8 biologically different colliphages capable of infecting various strains of E. coli and Shigella flexneri. Further studies on the genetics, physicochemical properties, and serologi-cal aspects of this problem are underway to char-acterize each of the virus isolates. (See also W91-10612) (Doria-PTT) W91-10663

DIRECT DETECTION OF ENTEROPATHO-GENIC BACTERIA IN ESTUARINE WATER USING NUCLEIC ACID PROBES.

Center of Marine Biotechnology, Baltimore, MD. I. T. Knight, J. DiRuggiero, and R. T. Colwell. Water Science and Technology WSTED4, Vol. 24, No. 2, p 261-266, 1991. 3 fig., 1 tab, 10 ref.

Descriptors: \*Bacterial analysis, \*Estuarine environment, \*Gene probes, \*Genetics, \*Measuring instruments, \*Nucleic acids, \*Pathogenic bacteria, \*Pollutant identification, \*Water analysis, Aquatic environment, Bacterial toxins, Bioindicators, Culturing techniques, DNA, RNA, Salmonella.

Direct detection and enumeration of pathogenic bacteria, rather than indicator organisms, in aquatic environments is desirable but hindered by the difficulties of culturing and identifying specific pathogens from these environments. A method was developed for concentrating these bacteria from water samples and extracting their DNA and RNA for use as targets for pathogen-specific gene probes. The method was used to detect and enumerate Salmonella spp. in estuarine water samples. The probe binds Salmonella DNA quantitatively, making it possible to estimate relative amounts of target in each sample. Salmonella spp. were detected in samples that yielded no Salmonella spp. using ed in samples that yielded no Samiolicias spp. using culturing. Since the probe method does not require culturing the target organism, both culturable and nonculturable forms are detected. Polymerase chain reaction was also used to amplify a region of the enterotoxin gene in enterotoxigenic Escheri-chia coli and Vibrio cholerae (Itx and ctx, respec-tively). The amplified products are then identified with ctx and Itx probes, making specific, highly

sensitive detection possible. (See also W91-10612) (Author's abstract) W91-10664

DETECTION OF HEPATITIS A VIRUS AND OTHER ENTEROVIRUSES IN WASTEWATER AND SURFACE WATER SAMPLES BY GENE PROBE ASSAY

Laboratoire d'Hygiene de la Ville de Paris (France).

(France).

S. Dubrou, H. Kopecka, J. M. Lopez Pila, J. Marechal, and J. Prevot. Water Science and Technology WSTED4, Vol. 24, No. 2, p 267-272, 1991. 2 fig. 3 tab, 13 ref.

Descriptors: \*Enteroviruses, \*Gene probes, \*Nucleic acids, \*Poblitant identification, \*Public health, \*Viruses, \*Wastewater analysis, Culturing techniques, Genetics, Human diseases, Pathogens, Sample preparation, Surface water, Water analysis, Water quality monitoring.

A specific hybridization test was developed for the detection of hepatitis A virus (HAV) and other enteroviruses by using subgenomic dRNA transcripts of poliovirus type 1 (PVI) and HAV synthesized in vitro (riboprobes). Enteroviruses were specifically detected by dot blot hybridization when using PVI-derived subgenomic radiolabelled cRNA probes in environmental water samples and in the cell cultures in which the viruses were amplified. The riboprobe corresponding to the 5' noncoding sequence detected the majority of enteroviruses. HAV was specifically detected by an HAV cRNA probe corresponding to the 5' noncoding region of its genome. By this test, the limit of detection of coxsackievirus B3 and echovirus 7 of detection of coxsackievirus B5 and echovirus 7 seeded in mineral water was 1,000 to 10,000 pfu/spot. In cell cultures, positive signals were observed in the lysates of cells infected by one plaque-forming unit (pfu). Higher positive signals were obtained with a short PVI probe (nt 221-670) corresponding to the 5' noncoding region, which is a well conserved sequence among the enteroviruses, than with PVI genomic probe. Hybridization allowed a good detection of enteroviral RNAs in wastewater samples, but with a lower efficiency in surface water. In this case, amplification of viruses in the cell cultures gave significant hybridization results. It is concluded that hybridization is a relatively rapid and specific tool for screening a large of detection of coxsackievirus B5 and echovirus 7 tively rapid and specific tool for screening a large number of water samples. (See also W91-10612) (Author's abstract) W91-10665

DETECTION OF POLIOVIRUS IN WATER BY DIRECT ISOLATION OF THE RNA AND HYBRIDIZATION WITH GENE PROBES.

Tuebingen Univ. (Germany, F.R.). Hygiene Inst. D. Tougianidou, and K. Botzenhart. Water Science and Technology WSTED4, Vol. 24, No. 2, p 273-276, 1991. 2 fig, 1 tab, 8 ref.

Descriptors: "Gene probes, "Genetics, "Nucleic acids, "Poliovirus, "Pollutant identification, "Viruses, "Water analysis, "Water quality monitoring, Adsorption, Cellulose, Enzymes, Filters, Filtration, Isolation, Public health, RNA.

A method is presented for rapid and low-cost detection of viruses in water by direct isolation of viral RNA after filtration through cylindrical cel-lulose ester filter units. Water seeded with poliovi-rus was filtered through Sterivex-OS filter units in the presence of AlCl3 to enhance viral adsorption. The filter material consisted of mixed cellulose The filter material consisted of mixed cellulose esters with a porosity of 0.22 microns. The isolation of RNA occurs in the cylindrical filter unit in the presence of RNAsse inhibitors proteinase K and sodium dodacyl sulfate (SDS); the RNA can then be detected with gene probes. The problem of limited filter capacity was overcome by filtering through 2 or more filter units. The use of prefilters is also possible, but leads to loss of virus. The cDNA probe used hybridizes mainly with politovirus types 1-3. There are some weak cross-reactions with some cossackie and echoviruses, but they can with some coxsackie and echoviruses, but they can be minimized by stringent washing conditions. The riboprobe is able to detect RNA of poliovirus types 1-3, coxsackie A virus types 7, 9, 11, and 33,

#### Group 5A-Identification Of Pollutants

and human rhinovirus type 2. For better identifica-tion of low RNA quantities, the isolated RNA can be amplified using polymerase chain reaction tech-niques. (See also W91-10612) (Doria-PTT) niques. (See W91-10666

APPLICATION OF A POLIOVIRUS CDNA PROBE FOR THE DETECTION OF ENTERO-VIRUSES IN WATER. New Hampshire Univ., Durham. Dept. of Microbi-

ology.
A. B. Margolin, M. J. Hewlett, and C. P. Gerba.
Water Science and Technology WSTED4, Vol.
24, No. 2, p 277-280, 1991. 4 tab, 6 ref.

Descriptors: \*DNA, \*Enteroviruses, \*Gene probes, \*Nucleic acids, \*Poliovirus, \*Pollutant identification, \*Viruses, \*Water analysis, \*Water quality monitoring, Comparison studies, Enzymes, Genetics, Hydrolysis, Optimization, Phosphorus radioisotopes, Public health, RNA.

A technique is described for the detection of enter-A technique is described for the detection of enter-oviruses in water using gene probes in a dot blot assay. Policovirus cDNA probes were labeled with (P32)dCTP and (P32)dATP to a specific activity greater than 2 billion cpm/microgram DNA. The viral cDNA probe was labeled while still inserted in the plasmid vector pBR322. Autoradiograph times were compared to determine the minimum time required to optimize the sensitivity of the test. One infectious unit of poliovirus was detected from cell harvests within 48 hours using gene probes. There does not seem to be an increase in the sensitivity of the assay system by increasing the exposure time from 36 to 48 hours for detection of poliovirus. Potential false positive reactions be-tween bacterial DNA in environmental samples iween bacterial DNA in environmental samples and vector DNA were controlled by both base hydrolysis of viral RNA and enzymatic treatment of the sample. Groundwater samples were tested to determine the effectiveness of gene probes in detecting naturally occurring viruses. Results were compared to those obtained by cell culture and dot blot assay. Four of ten groundwater samples were positive by gene probes, while five were positive by cell culture. Only one sample was positive by standard cell culture techniques and negative by the dot blot assay. (See also W91-10612) (Doria-PTT) W91-10667

DETECTION OF ROTAVIRUSES IN WATER BY GENE PROBES

Arizona Univ., Tucson. Dept. of Microbiology and Immunology.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 281-284, 1991. 1 fig, 2 tab, 6 ref.

Descriptors: \*Gene probes, \*Genetics, \*Nucleic acids, \*Pollutant identification, \*Rotaviruses, \*Viruses, \*Wastewater analysis, \*Water quality monitoring, Chlorine, Culturing techniques, Drinking water, Enteroviruses, Enzymes, Proteins, RNA, Rivers, Spain, Water pollutions, \*Poteins, RNA, Rivers, RNA, RIVers,

Rotavirus-incorporated transcriptase was used to amplify rotaviral mRNA in environmental samples prior to detection by gene probes. Of sewage samprior to detection by gene probes. Of sewage samples tested, 35% were positive for rotaviruses by in vitro transcription/gene probe hybridization. Fifteen of the 20 samples tested were positive for enteroviruses by cell culture. Only 1 of 16 tap water samples was positive. The tap water contained 0.3 mg/L of free chlorine and was negative for enteroviruses by tissue culture. It was also negative for nonspecific probe binding. Nine surface water samples were tested by probe hybridization after in vitro transcription. Two samples from rivers in Spain suspected of sewage contamination were weakly positive. Both samples were negative for nonspecific binding of probe. One of these samples was also positive for enteroviruses by cell samples was also positive for enteroviruses by cell culture. It is concluded that in vitro transcription can be used as an amplification method for deteccan be used as an amplification method for detec-tion of rotaviruses by gene probes. Sephadex G-200 spun columns can be used to remove beef extract proteins while permitting in vitro amplifi-cation. A cloned copy of segment 4 of Wa rotavirus can be used to detect human rotavirus in water. Probing of positive samples with plasmid without vector can be used to detect nonspecific binding of probe. (See also W91-10612) (Doria-PTT) W91-10668

GROWTH OF CLINICAL ISOLATES OF ASTROVIRUS IN A CELL LINE AND THE PREP-ARATION OF VIRAL RNA. Sunderland Polytechnic (England). School of Biol-

ogy. A. P. Wyn-Jones, and A. J. Herring. Water Science and Technology WSTED4, Vol. 24, No. 2, p 285-290, 1991. 2 fig, 9 ref.

Descriptors: \*Astroviruses, \*Culturing techniques, \*Nucleic acids, \*Pollutant identification, \*RNA, \*Sample preparation, \*Viruses, \*Water analysis, \*Water quality monitoring, DNA, Feces, Gene

Astroviruses from three sources were processed to extract the RNA: of human origin, adapted to cell culture growth by passage in primary tissue; direct from feces; and of lamb origin, from gut epithelium scrapings. The first two of these were also com-pared in their growth on LLCMK2 and Caco-2 cell lines. Virus was successfully isolated direct cell lines. Virus was successfully isolated urrect from feces in the latter line, although it failed to grow in LLCMK2. Previously adapted virus continued to grow well in both lines. RNA was extracted from the ovine virus in a condition which permitted the production of cDNA prior to cloning, but the RNA from the human astroviruses was referently to extraction owing to its aggregamore refractory to extraction owing to its aggrega-tion with cell debris. This study demonstrated that Caco-2 cells, of intestinal epithelium origin, are capable of supporting the production of astrovirus antigen from samples that had not had prior pasantigen from samples that had not had prior pas-sage in primary cell culture. The preparation of RNA from clinical material, in this case lamb astrovirus, should facilitate the later preparation of cDNA probes, especially if astroviruses show the same extent of sequence conservation as is seen in the picornaviruses. It is concluded that, provided adequate concentration methods are available, the potential now exists for the incidence of astrovir-uses to be determined in the aquatic environment. (See also W91-10612) (Doria-PTT) W91-10669

PCR AND ENVIRONMENTAL MONITORING: THE WAY FORWARD. Lancaster Univ. (England). Inst. of Environmental

and Biological Sciences.

L. M. Alexander, and R. Morris. Water Science and Technology WSTED4, Vol. 24, No. 2, p 291-294, 1991. 6 ref.

Descriptors: \*DNA, \*Nucleic acids, \*Pollutant identification, \*RNA, \*Viruses, \*Water analysis, \*Water quality monitoring, Chemical interference, Coastal waters, Culturing techniques, Enterovir-uses, Enzymes, Gene probes, Genetics, Polymerase chain reaction, Surface water.

The polymerase chain reaction (PCR) has immeasurable potential if applied to the detection of enter-oviruses in water, as it can detect both DNA and RNA viruses. Unlike traditional tissue culture methods or molecular probes, the amplification of distinct genomic segments from different viruses can be accomplished using different oligonucleo-tides to prime PCR. This would facilitate not only group detection, such as the presence or absence of enteroviruses in a given water sample, but also the distinction between different serotypes, such as poliovirus types 1, 2, and 3. However, as is the case with any enzymatic reaction, PCR is easily inhibited by the presence of components of surface waters and probably coastal waters. While PCR is undoubtedly a powerful tool, its sensitivity is inex-tricably linked to the cleanliness, or purity, of the water concentrates from which nucleic acids are to be extracted. Until the issues of adaptability, inhi tion, infectivity, and quantification have been ad-dressed, it is unlikely that PCR can be applied reliably, on a routine basis, to the detection and monitoring of enteroviruses in environmental sam-ples. The issue of false positives and false negatives, which is a major consideration in the applica-tion of PCR to the testing of clinical samples, should continue to be given equal importance in assessing whether or not PCR is the way forward for environmental monitoring. (See also W91-10612) (Doria-PTT) W91-10670

ASSESSMENT OF METHODS FOR THE MI-CROBIOLOGICAL ANALYSIS OF SHELL-

Pretoria Univ. (South Africa). Dept. of Medical

Virology. W. O. K. Grabow, J. C. de Villiers, and N.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 413-416, 1991. 2 tab, 6 ref.

Descriptors: \*Bacterial analysis, \*Bacteriophage, \*Pollutant identification, \*Shellfish, \*Tissue analysis, \*Viruses, Agars, Coliforms, Culturing techniques, Enteric bacteria, Enzymes, Filtration, Growth media, Membrane filters, Microbiological studies, Most probable number test, Oysters, Sea mussels, Wastewater.

The efficiency of membrane filtration (MF) techniques and most probable number (MPN) tube dilution assays for the bacteriological analysis of homogenized oyster and mussel meat was comnomogenized oyster and musel meat was com-pared. Tests were done on naturally contaminated shellfish and on homogenates seeded with sewage. Digested homogenates (5% trypsin for 20 min at 37 C) were prefiltered (pore size 5 microns) and then filtered (pore size 0.45 microns) for MF counts. Undigested homogenates and dilutions were inoculated into tubes with growth medium for MDN tests. Homogenetic citis on without for MPN tests. Homogenates (with or without trypsin) were used directly in a toplayer method for the detection of coliphages. Trypsin digestion significantly reduced counts of total coliform bacteria, but not of fecal coliform bacteria, enterococci, or coliphages. Prefiltration considerably reduced counts of bacteria, and, to a lesser extent, duced counts of bacteria, and, to a lesser extent, also of coliphages. As a result, MPN tests using minerals-modified-glutamate broth yielded higher counts of coliform bacteria than MF tests using mEndo LES and mTEC agar. The latter yielded higher counts of fecal coliforms than mFC agar. In the case of entercococi, the MF procedure yielded lower counts than a spread plate test using undilower counts than a spread plate test using undi-gested homogenates. The favorable results ob-tained with spread plates in tests for enterococci suggest that spread plates may also prove superior to the MPN procedure for fecal coliforms. In this case, mTEC agar, which yielded higher average counts than mFC agar, would probably be the growth medium of choice. (See also W91-10612) (Author's abstract) W91-10695

DETOXIFICATION BY SEPHADEX LH20 OF SEAFOOD CONCENTRATES FOR ROTA-VIRUS ASSAY.

VIRUS ASSAT.

Nancy-1 Univ. (France). Faculte de Pharmacie.
C. Beril, S. Boher, and L. Schwartzbrod.

Water Science and Technology WSTED4, Vol.
24, No. 2, p 417-421, 1991. 3 tab, 9 ref.

Descriptors: \*Assay, \*Bioassay, \*Detoxification, \*Gels, \*Rotaviruses, \*Sample preservation, \*Shell-fish, \*Viruses, Culturing techniques, Filtration, Mollusks, Oysters, Sea mussels, Toxicity.

Virological analysis of seafood is often limited by the toxic effects of the mollusk concentrates on cell cultures. A detoxification method was developed based on filtration through a Sephadex LH20 gel. For oysters results show that after LH20 filtration octotoxicity decreased by a factor of 4-10 in total octotoxicity decreased by a factor of 4-10 in 55.5% of concentrates, inferior to 4 in 22% and superior to 10 in 22%. There was no significant difference in viral titre before and after filtration in 77% of cases, a significant decrease in 11% of cases, and a significant increase in 11% cases after filtration. Analysis of mussel concentrates showed that LH20 Analysis of museel concentrates showed that LH20 Sephades gel filtration reduced toxicity by a factor of 4-10 in 79% of cases, inferior to 4 in 16% and superior to 10 in 5%. The viral titre did not show any significant difference in 74% of cases. In 16%

#### Identification Of Pollutants-Group 5A

the titre obtained after detoxification was signifithe tire obtained after detoxification was signifi-cantly lower, and in 10% no rotaviruses were isolated after LH20 Sephadex gel filtration. In order to verify that LH20 Sephades filtration does not lead to a loss of viral particles, a rotavirus suspension was titrated 3 times before and after filtration on LH20 Sephadex gel. Results showed that there is no significant decrease of viral suspension titre after filtration. LH20 Sephadex gel filtration is a simple method for decreasing shellfish toxicity and improving virus recovery from these organisms. (See also W91-10612) (Doria-PTT) organisms. W91-10696

COMPARISON OF TWO METHODS FOR THE RECOVERY OF ROTAVIRUS FROM MUS-SELS AND OYSTERS. Nancy-1 Univ. (France). Faculte de Pharmacie. S. Boher, C. Beril, D. Terver, and L.

S. Boher, C. Berli, D. Terver, and D. Schwartzbrod.
Water Science and Technology WSTED4, Vol. 24, No. 2, p 423-426, 1991. 2 fig, 12 ref.

Descriptors: \*Mussels, \*Oysters, \*Pollutant identification, \*Rotaviruses, \*Shellfish, \*Viruses, Comparison studies, Extraction techniques, Flocculation, Hydrogen ion concentration, Mollusks, Seawater. Tissue analysis.

Two extraction-concentration methods for recovering rotavirus from mussels and oysters were compared. One method used was elution with 0.1 M borate-beef extract solution at pH 9 and concentration by polyethylene glyeol (PEG) 6000 double tration by polyethylene giyeoi (PEG) 6000 double precipitation. The other method was based on elution with 0.1 M glycine at pH 10 associated with organic flocculation. Mollusks were artificially contaminated by a one-hour stay in seawater seeded with rotavirus SA 11. The recovery of rotaviruses from musels depended on the procedure. With glycine-organic flocculation, the rotavirus recovery level was identical at all virus con-centrations in seawater. With the borate-beef excentrations in seaward. With the obtained for rota-tract-PEG 6000 procedure, the quantities of rota-virus recovered from mussel tissue depended on seawater contamination. When rotaviruses were less than fluorescent foci (100) FF/ml in seawater, their recovery was less efficient than that obtained their recovery was less efficient than that obtained by glycine-organic flocculation. With 100 to 320 FF rotavirus/ml seawater, the recovery is more efficient when using the borate-beef extract-PEG 6000 procedure. Oyster contamination was always made in seawater containing more than 67 FF rotavirus/ml. The borate-beef extract-PEG 6000 rotavirus/mi. The borate-beef extract-F25 door method gave significantly higher rotavirus recovery than the glycine-organic flocculation method. The borate-beef extract method provides more efficient rotavirus recovery and can be recommended for rotavirus extraction and concentration from shellfish. (See also W91-10612) (Doria-PTT) W91-10697

COMPARISON OF METHODS FOR THE ISO-LATION OF A WIDE RANGE OF VIRUSES FROM SHELLFISH.

Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology. G. K. Idema, B. W. Bateman, R. Kfir, and W. O. K. Grabow.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 427-430, 1991. 2 tab, 11 ref.

Descriptors: \*Enteroviruses, \*Pollutant identifica-tion, \*Shellfish, \*Viruses, Adsorption, Comparison studies, Desorption, Hydrogen ion concentration, Isolation techniques, Tissue analysis

Four methods were compared for the isolation of a wide range of enteric viruses from shellfish. Three of the methods (A, B, and C) were based on viral adsorption and desorption using buffers at different pH values. A fourth method (D) consisted of a single homogenization step with no pH adjust-ments. High recoveries for polio 1 were shown ments. High recoveries for polio I were shown with the first three methods, namely 81%, 79%, and 77%, respectively. Recoveries for reo I (Lang strain) and the simian rotavirus SA11 were not satisfactory using methods A-C. By contrast, method D gave high recoveries for reo and SA11 virus (31% and 68%, respectively). A modified method D generally yielded higher recoveries as indicated by a 91%, 33%, and 35% recovery for polio 1, reo, and SA11 viruses, respectively. Comparison of method A and modified method D for the detection of viruses from environmental shell-fish samples indicated that the two methods were fish samples indicated that the two methods were of equal sensitivity. The higher recoveries of reo and SA11 by method D could be due to a reduced effect of pH on adsorption and desorption compared to poliovirus, especially at low conductivity. An additional concentration step could increase the recovery and detection capabilities of the modified method even further. Method D is a very short and practical method that could be applied with ease to recover a high percentage of a wide range of viruses. (See also W91-10612) (Doria-PTT) W91-10698

INSTALLATION OF THE WESTBAY MULTI-PORT GROUND-WATER SAMPLING SYSTEM IN WELL 699-43-42K NEAR THE 216-B-3 POND.

Battelle Pacific Northwest Labs., Richland, WA. For primary bibliographic entry see Field 7B. W91-10720

PHOSPHORUS IN THE TRUCKEE RIVER BETWEEN VISTA AND PATRICK, STOREY AND WASHOE COUNTIES, NEVADA, AUGUST

Geological Survey, Carson City, NV.

Available from the US Geological Survey, Books and Open-File Reports Section, Federal Center, Box 25425, Denver, CO 80225-0425. Water-Re-sources Investigations Report 89-4175, 1990. 33p, 11 fig, 6 tab, 19 ref.

Descriptors: \*Lake Tahoe Basin, \*Monitoring, \*Nevada, \*Phosphorus, \*Sampling, \*Truckee River, \*Water analysis, \*Water sampling, Dissolved oxygen, Dissolved solids, Pyramid Lake, Reno, Sewage disposal, Sparks, Storey County, Streamflow, Trace elements, Traveltime, Washoe County, Water quality data, Water quantity.

During calibration of a numerical water quality model of the Truckee River below Reno, Nevada, the modeling results showed an undocumented accretion of phosphorus between Lockwood and Patrick at streamflows of about 300 cu ft/sec. An examination of available historical data tended to examination of available instorical data reflued to support the observed increase. In August 1984, at a streamflow of about 300 cu f/sec, a diel sampling program was undertaken at four stations along a 7.3-mile reach of the river to determine if the undocumented input of phosphorus was real, or was due to errors associated with water quality sampling procedures, or the river's traveltime, or both. Water samples were collected using the equal-discharge-increment method across the stream, for the analysis of phosphorus, chloride, sulfate, and arsenic. On-site measurements included specific conductance, dissolved oxygen, water temperature, and pH. All water quality data were temperature, and pH. All water quality data were collected every 2 hours and instantaneous streamflow was measured about every 3 hours at each station. The results of field work and a thorough analysis of past sampling programs in the Truckee River suggest that the apparent increase in phosphorus between Lockwood and Patrick was most likely the result of sampling protocol in association with the river's time of travel, compounded by fluctuating phosphorus loads from an upstream wastewater treatment plant near Reno during periods of moderate streamflow. During high streamflow conditions, the increase may also have been the result of the resuspension of particulate phosphorus. (Author's abstract)

CONE PENETROMETER TESTS AND HY-DROPUNCH SAMPLING: A SCREENING TECHNIQUE FOR PLUME DEFINITION.

EMCON Associates, San Jose, CA. M. Smolley, and J. C. Kappmeyer. Ground Water Monitoring Review GWMRDU, Vol. 11, No. 2, p 101-106, Spring 1991. 4 fig, 2 tab,

Descriptors: \*Groundwater pollution, \*Monitoring, \*Path of pollutants, \*Plumes, \*Volatile organic compounds, Aquifer characteristics, Cone penetrometer test, Cost analysis, Data acquisition, Field tests, HydroPunch sampling, Monitoring wells, Sampling, Wall data Sampling, Well data.

Cone penetrometer tests and HydroPunch sampling were used to define the extent of volatile organic compounds in groundwater. The investigaorganic compounds in groundwater. In envestiga-tion indicated that the combination of these tech-niques is effective for obtaining groundwater sam-ples for preliminary plume definition. HydroPunch samples can be collected in unconsolidated sediments and the analytical results obtained from these samples are comparable to those obtained from adjacent monitoring wells. This sampling method is a rapid and cost-effective screening techinque for characterizing the extent of contaminant plumes in soft sediment environments. Use of this screening technique allowed monitoring wells to be located at the plume boundary, thereby reduc-ing the number of wells installed and the overall cost of the plume definition program. (Author's W91-10794

FIELD SAMPLING OF RESIDUAL AVIATION GASOLINE IN SANDY SOIL.

Massachusetts Univ., Amherst, Dept. of Civil En-

D. W. Ostendorf, L. E. Leach, E. S. Hinlein, and

Ground Water Monitoring Review GWMRDU, Vol. 11, No. 2, p 107-120, Spring 1991. 6 fig. 10 tab, 17 ref, append. U. S. Environmental Protec-tion Agency Contract CR 816821.

Descriptors: \*Field tests, \*Gasoline, \*Monitoring, \*Pollutant identification, \*Sampling, \*Soil analysis, \*Soil contamination, Analytical methods, Comparison studies, Cores, Gas chromatography, Precision, Sand, Soil profiles.

Two complementary field sampling methods were evaluated for the determination of residual aviation gasoline content in the contaminated capillary fringe of a fine, uniform, sandy soil. The first method featured field extrusion of core barrels into pint-size Mason jars, while the second consisted of laboratory partitioning of intact stainless steel core sleeves. The barrel extrusion procedure involved jar headspace sampling in a nitrogen-filled glove box. Soil samples removed from the Mason jars (in the field) and sleeve segments (in the laboratory) were subjected to methylene chloride extraction and gas chromatographic analysis to compare their aviation gasoline content. The barrel extrusion sampling method yielded a vertical profile with 0.10m resolution over an essentially continuous 0.10m resolution over an essentially continuous 5.0m interval from the ground surface to the water table. The sleeve segment alternative yielded a more resolved 0.03m vertical profile over a shorter 0.8m interval through the capillary fringe. The two methods delivered precise estimates of the verticalmethods delivered precise estimates of the vertical-ply integrated mass of aviation gasoline at a given horizontal location, and a consistent view of the vertical profile as well. The maximum peak was resolved by the core sleeve data, but was partially obscured by the barrel extrusion observations, so that replicate barrels or a half-pint Mason jar size should be considered for data supporting vertical transport analyses in the absence of sleeve parti-tions. (Author's abstract) W91.10795 W91-10795

METHOD FOR ASSESSING RESIDUAL NAPL BASED ON ORGANIC CHEMICAL CONCEN-TRATIONS IN SOIL SAMPLES.

Applied Groundwater Research Ltd., Mississauga (Ontario).

S. Feenstra, D. M. Mackay, and J. A. Cherry Ground Water Monitoring Review GWMRDU, Vol. 11, No. 2, p 128-136, Spring 1991. 2 fig, 6 tab,

Descriptors: \*Groundwater pollution, \*Organic compounds, \*Pollutant identification, \*Soil contamination, Chemical analysis, Cost analysis, Moni-

#### Group 5A—Identification Of Pollutants

toring, Porosity, Sampling, Soil analysis, Soil mois-ture content, Soil tests, Solubility, Sorption.

Groundwater contamination by non-aqueous phase liquid (NAPL) chemicals is a serious concern at many industrial facilities and waste disposal sites. In order to develop rational and cost-effective plans for remediation of soil and groundwater conplans for remediation of soil and groundwater con-tamination at such sites, it is essential to determine if NAPL chemicals are present in the subsurface and delineate the zones of NAPL contamination. A method has been developed to allow investiga-tors of chemical spill and waste disposal sites to address whether soil chemical analyses indicate the presence of residual NAPL in the subsurface. The method requires information on the soil gathered method requires information on the soil gathered in groundwater contamination studies: total chemiin groundwater contamination studies: total chemical concentrations, moisture content, porosity, sorption parameters for the chemicals of interest, and physical and chemical properties of the chemicals of interest. Conclusions regarding the presence of NAPL in soil samples are most reliable for cases where significant residual NAPL is present; the pore water-soil partition coefficients can be measured for the compounds of interest; and for single component or multicomponent NAPL for which the effective solubility of the components can be measured. The determination of the presence of NAPL is less reliable when parameters such as sorption coefficients and effective solubility must be estimated. However, at the present time calculations. be estimated. However, at the present time calcula-tions such as this provide the only method for the determination of residual NAPL in soil samples until laboratory analysis methods are developed which can confirm the presence of low levels of NAPL contamination directly. (Korn-PTT)

SPECTROPHOTOMETRIC DETERMINATION OF NITRITE IN POLLUTED WATERS USING 3-NITROANILINE.

Aligarh Muslim Univ. (India). Chemistry Section. H. P. S. Rathore, and S. K. Tiwari. Analytica Chimica Acta ACACAM, Vol. 242, No. 2, p 225-228, February 1991. 3 tab, 23 ref.

Descriptors: \*Analytical methods, \*Chemical analysis, \*Nitrites, \*Pollutant identification, \*Spectrophotometry, \*Water analysis, Chemical reactions, Chemical reagents, Hydrogen ion concentration, Interference, Laboratory methods, Reproducibility

Nitrite reacts with 3-nitroaniline in the presence of Nitrite reacts with 3-nitroaniline in the presence of hydrochloric acid to form a diazonium cation, which is subsequently coupled with N-(1-naphthyl)ethylenediammonium chloride to form a stable purple azo dye. The method is suitable for the determination of 0.01-0.80 microgram/ml nitrite. The reactions are very fast and require no control of temperature. The observed molar absorptivity and Sandell's sensitivity of the azo dye were 49.000 L/mol/cm and 0.00094 micrograms/ sq cm, respectively. The method is free from most interferences and has been applied successfully to polluted river water. The rapidity, simplicity, reroducibility, freedom from htt fefects, temperareducibility, freedom from https://doi.org/10.1001/j.j.j. producibility, freedom from pH effects, tempera-ture independence and high tolerance limits for a large number of foreign ions are significant advan-tages of this method. (Medina-PTT) W91-10823

SIMULTANEOUS ULTRAVIOLET SPECTRO-PHOTOMETRIC DETERMINATION OF NI-TRATE AND NITRITE IN WATER.

Department of Polymer Chemical Engineering, Liaoyang Petrochemical College, Liaoyang, Liaovang

H. Dong, M. Jiang, and Q. Zhang. Analytical Letters ANALBP, Vol. 24, No. 2, p 305-315, 1991. 3 fig, 3 tab, 5 ref.

Descriptors: \*Analytical methods, \*Chemical analysis, \*Nitrates, \*Nitrites, \*Pollutant identification, \*Spectrophotometry, \*Water analysis, \*Water pollution, Chemistry of precipitation, Laboratory methods, Measuring instruments, Rain, Ultraviolet radiation, Wastewater analysis.

A rapid and accurate method for the direct simulis ultraviolet spectrophotometric determina-

tion of nitrate and nitrite in environmental pollution to intrate and intrite in environmental point-tion studies is proposed based on the CPA matrix method (C=PA where C is the matrix of the standard mixtures, A is the absorbance matrix and P is the matrix representing the proportionality between C and A). The analytical wavelengths and the various parameters affecting the determination of nitrate and nitrite were investigated and applied or mirate and mirate were investigated and applied to the measurement of these compounds in rainwater and wastewater without preliminary separation. Compared with conventional methods for nitrite and nitrate determination, the proposed method offers greater convenience, and higher sensitivity and sampling frequency. (Medina-PTT) sitivity and sampling frequency. (Medina-PTT)
W91-10824

EFFECT OF 3,4-DICHLOROANILINE ON THE EARLY LIFE STAGES OF THE ZEBRAFISH (BRACHYDANIO RERIO): RESULTS OF A COMPARATIVE LABORATORY STUDY. Mainz Univ. (Germany, F.R.). Inst. fuer Zoologie. R. Nagel, H. Bresch, N. Caspers, P. D. Hansen,

and M. Markert.

Ecotoxicology and Environmental Safety EESADV, Vol. 21, No. 2, p 157-164, April 1991. 5 tab. 15 ref.

Descriptors: \*Bioassay, \*Toxicity, \*Toxicology, \*Water pollution effects, Germany, Laboratory methods.

In Germany, Stage 2 of the Chemicals Act requires a long-term fish test which must also include re-production. An early life stage (ELS) test was conducted with the zebrafish and 3,4-dichloroaniline (3,4-DCA) in eight laboratories. Based on the results from all eight laboratories, an LOEC (laboresults from all engin hoovaries, an Doc (hoovarietory-determined observed effect concentrations) of 200 micrograms 3,4-DCA/liter applies for the early life stages of the zebrafish. Effects observed were reduction of the survival rate and malformations. If the 100 microgram/liter concentration ad-ditionally tested by one laboratory is included in the assessment, an LOEC of 100 micrograms 3,4the assessment, an LOEC of 100 micrograms 3,4-DCA/liter is obtained for the survival rate and increase in length. The NOEC (no-observed effect concentrations) is 20 micrograms/liter. The present results of a comparative laboratory study with the zebrafish show that a 42-day ELS test can be conducted with this species of fish, and can afford meaningful results. (Author's abstract) W91-10828

ECOTOXICOLOGICAL EFFECTS ASSESS-MENT: A COMPARISON OF SEVERAL EX-TRAPOLATION PROCEDURES.

Rijksinstituut voor de Volksgezondheid en Milieu-hygiene, Bilthoven (Netherlands). P. C. Okkerman, E. J. Plassche, W. Slooff, J. C. P. C. OKKETHAII, L. J. I INSTANCE, Van Leeuwen, and J. H. Canton. Ecotoxicology and Environmental Safety EESADV, Vol. 21, No. 2, p 182-193, April 1991. 1 fig, 6 tab, 17 ref.

Descriptors: \*Bioassay, \*Hazard assessment, \*Risk assessment, \*Toxicity, \*Toxicology, Acute toxicity, Algae, Aquatic life, Chronic toxicity, Comparison studies, Daphnia, Mathematical models.

In the future, extrapolation procedures become more and more important for the effect assessment of compounds in aquatic systems. For achieving a reliable method these extrapolation procedures have to be evaluated thoroughly. As a first step three extrapolation procedures were com-pared by means of two sets of data consisting of (semi)chronic and acute toxicity test results of 11 (semichronic and acute toxicity test results of 11 aquatic species and 8 compounds. Because of its statistical basis the extrapolation procedure of Van Straalen and Denneman, which uses the log-logistic distribution, was preferred over the procedures of the EPA and Stephen et al, which uses the triangular distribution. The results of the calculations of the content of the calculations of the content of the calculations of the content of the calculations of the c triangular distribution. The results of the calcularions showed that lower numbers of toxicity data increase the chance of underestimating the risk of a compound. Therefore it is proposed to extend the Organization for Economic Cooperation and Development guidelines for algae, Daphnia, and fish with chronic (aquatic) toxicity tests for more species of different taxonomic groups. (Author's abW91-10830

ACUTE AQUATIC TOXICITY OF ALKYL PHENOL ETHOXYLATES.

Bayer A.G., Leverkusen (Germany, F.R.). For primary bibliographic entry see Field 5C. W91-10833

PULSED FIELD ELECTROPHORESIS OF GENOMIC RESTRICTION FRAGMENTS FOR THE DETECTION OF NOSOCOMIAL LE-GIONELLA PNEUMOPHILA IN HOSPITAL WATER SUPPLIES.

WATER SUPPLIES.
Wuerzburg Univ. (Germany, F.R.). Inst. fuer Genetik und Mikrobiologie.
M. Ott, L. Bender, R. Marre, and J. Hacker.
Journal of Clinical Microbiology JCMIDW, Vol.
29, No. 4, p. 813-815, 1991. I fig. 16 ref. Bundesministerium für Forschung und Technologie Grants
BMFT 01Ki 8829 and 01Ki 8812.

Descriptors: \*Bacterial analysis, \*Electrophoresis, \*Germany, \*Legionella, \*Pathogenic bacteria, \*Public health, \*Water supply, Genetics, Laboratory methods, Water conveyance.

Nosocomial infections account for a high percent-Nosocomial infections account for a high percentage of cases of legionellosis in different countries. Ten L. pneumophila strains isolated from different sources were analyzed according to their restriction fragment patterns obtained by cleavage of genomic DNA with NotI and Sfil and separation genomic DNA with Nott and Stil and separation by pulsed field electrophoresis. Three L. pneumo-phila isolates from a nosocomial outbreak in Lu-beack (Germany) and three other L. pneumophila strains independently isolated from a water tap located in the care unit where the patients were hospitalized exhibited identical restriction fragment profiles. Therefore, it is concluded that these environmental specimens were the source of Legion-naires disease. Another two isolates from patients matter suscass. Another two isolates from patients and two strains from the environment, all unrelated to the outbreak described, showed different cleavage patterns. (Author's abstract) W91-10836

IMMUNOCHEMICAL DETECTION OF CY-TOCHROME P450IA1 INDUCTION IN COD LARVAE AND JUVENILES EXPOSED TO A WATER SOLUBLE FRACTION OF NORTH SEA CRUDE OIL.

Bergen Univ. (Norway). Dept. of Biochemistry. A. Goksoyr, T. S. Solberg, and B. Serigstad. Marine Pollution Bulletin MPNBAZ, Vol. 22, No. 3, p 122-127, March 1991. 6 fig. 1 tab, 28 ref.

Descriptors: \*Bioassay, \*Bioindicators, \*Cod, \*Immunoassay, \*Oil pollution, \*Toxicity, \*Toxicology, \*Water pollution effects, Analytical methods, Cytochromes, Fish eggs, Fish larvae, Sublethal effects, Tissue analysis.

Using a flow-through biotest exposure system, cod eggs, larvae and juveniles were exposed to the water-soluble fraction (WSF) of North Sea (Stratfeggs, inrake and juvenines were exposed to the water-soluble fraction (WSF) of North Sea (Stratf-jord B) crude oil at concentrations ranging from 40-300 micrograms/L (ppb) for 1-6 weeks. The WSF was analyzed by gas chromatography/mass spectrometry (GC/MS), and was shown to be dominated by low-aromatic compounds such as benzenes, toluene and xylenes (80-90%). Cytochrome P450IA1 levels were measured by immunochemical techniques in 10,000 X g supernatants of whole larvae or juvenile gill homogenates, and in juvenile liver microsomal fractions. With rabbit anti-cod P450IA1 IgA as primary antibody in an indirect enzyme-linked immunosorbent assay (ELISA), a clear induction response was observed in the exposed groups of both larvae and juveniles. The response was dose-dependent, and recovery in clean sea-water resulted in normalization of the induced P450IA1 levels. In larvae exposed during induced P450AI1 levels. In larvae exposed during the egg stage, the induction process seemed re-stricted until the time of hatching. In juvenile cod, the response was observed in the gill in addition to the liver. The study demonstrates the usefulness of the cytochrome P450AII ELISA in detecting sublethal biological effects of pollutants in

#### Identification Of Pollutants-Group 5A

sample sizes where enzyme activity is difficult to measure. (Author's abstract) W91-10871

PATELLA VULGATA, MYTILUS MINIMUS AND HYALE PREVOSTI AS BIOINDICATORS FOR PB AND SE ENRICHMENT IN ALEXAN-

PUR PB AND SE ENRICHMENT IN ALEAAN-DRIA COASTAL WATERS. Alexandria Univ. (Egypt). Dept. of Oceanography. A. R. Abdel-Moati, and M. M. Atta. Marine Pollution Bulletin MPNBAZ, Vol. 22, No. 3, p 148-150, March 1991. 1 fig, 1 tab, 2 ref.

Descriptors: \*Bioaccumulation, \*Bioindicators, \*Egypt, \*Heavy metals, \*Lead, \*Marine pollution, \*Pollutant identification, \*Selenium, \*Water pollution effects, Agricultural runoff, Alexandria, Amphipods, Bivalves, Coastal waters, Industrial wastewater, Limpets, Sea mussels, Wastewater pollution

The concentrations of Pb and Se in the limpet Patella vulgata, the bivalve Mytilus minimus, and the amphipod Hyale prevosti at 6 intertidal locations off the Alexandria coast were investigated. The sampled stations were under the direct stress of untreated agricultural/industrial or sewage discharge. Generally, the capacity of Mytilus in accumulating Pb was higher than Patella and Hyale while for Se the sequence was Patella > Hyale > Mytilus. The feeding habit for each species influences the Pb and Se content of tissue and thus the presence of Pb in both soluble and particulate forms in water render it more available to filter feeding bivalves. The heterogeneity in shell measurements for Patella and Mytilus at different sampling, sites masks the appearance of a statistically pling sites masks the appearance of a statistically significant relation between shell measurements and Pb and Se content. The simple linear log regression between dry weight and concentratio indicated a decrease in concentration with increase indicated a decrease in concentration with increas-ing animal weight, which is partially attributed to the higher metabolic rate of smaller organisms. In the absence of M. edulis in Alexandria coastal waters, M. minimus will serve as a bioindicator for Pb and Se enrichment; Patella and Hyale should also be considered. (Sand-PTT)

DETERMINATION OF CHLORINATED PHENOXY ACID AND ESTER HERBICIDES IN SOIL AND WATER BY LIQUID CHROMA-TOGRAPHY PARTICLE BEAM MASS SPECTROMETRY AND ULTRAVIOLET ABSORPTION SPECTROPHOTOMETRY.

TION SPECIROPHOTOMETRY.
California Dept. of Health Services, Berkeley.
Hazardous Materials Lab. Section.
I. S. Kim, F. I. Sasinos, R. D. Stephens, J. Wang,

Analytical Chemistry ANCHAM, Vol. 63, No. 8, p 819-823, April 15, 1991. 5 fig, 4 tab, 8 ref.

Descriptors: \*Analytical methods, \*Chlorinated hydrocarbons, \*Herbicides, \*Liquid chromatography, \*Mass spectrometry, \*Phenoxy acid herbicides, \*Photometry, \*Pollutant identification, Chemical analysis, Hydrolysis, Quantitative analysis, Soil analysis, Water analysis.

Eight chlorinated phenoxy acid and three ester Eight chlorinated phenoxy acid and three ester herbicides are determined in soil and water by liquid chromatography with UV absorption for quantitation and particle beam mass spectrometry for confirmation. Chromatography using a C-18 reversed-phase column, 22 cm x 2.1 mm, water with methanol or acetonitile and acetic acid mobile phase, 0.25 mL/min flow, with UV detection (230 nm) gives quantitation limits of 12-80 ng in 10 microlitet piecetd volume (corresponding to tion (230 nm) gives quantitation limits of 12-90 ng in 10 microliter injected volume (corresponding to 4.8-32 ppb in 125 mL of water and 20-133 ppb in 30 g of soil and 500 microliter of final extract volume) with four-point calibration (R > 0.99). Full scan electron ionization particle beam mass spectra are given for chlorinated phenoxy acids at 1.25 microgram each on-column, showing molecular and phenoxy (base) ions. Both acids and esters are efficiently and cleanly extracted from soil and water with ethyl acetate, and the esters are base hydrolyzed before analysis. The average recovery of eight carboxylic acids spiked into water at 33.3, 1.0, and 0.1 ppm and spiked into soil at 33.3 and 1.0

ppm is 78% (average standard deviation 4.2%). The average recovery and ester hydrolysis efficiency for the three esters 2,4-D mixed isobutyl, 2,4,5-T butoxyethanol ether, and 2,4-DB isobutyl spiked at the same levels in soil and water is 88% (average standard deviation 10%). (Author's abstract) stract) W91-10893

CHROMATOGRAPHIC SEPARATION OF AR-SENIC SPECIES WITH SODIUM BIS(TRIFLUOROETHYL)DITHIOCARBAMATE

CHELATION.
Idaho Univ., Moscow. Dept. of Chemistry.
J. J. Yu, and C. M. Wai.
Analytical Chemistry ANCHAM, Vol. 63, No. 8,
p 842-845, April 15, 1991. 3 fig. 1 tab, 13 ref. NSF
Grant RII-8902065.

Descriptors: \*Analytical methods, \*Arsenic compounds, \*Chemical analysis, \*Chromatography, \*Pollutant identification, \*Separation techniques, \*Water analysis, Chelation, Gas chromatography, Heavy metals, Hydrogen ion concentration, Quantitative analysis, Thermal properties, Volatility.

Selective chelation followed by chromatographic Selective chelation followed by chromatographic separation is one method of analyzing arsenic species. The low volatility and thermal instability of arsenic species of diethyldithiocarbamate (DDC) make it difficult for quantification. Substitution of fluorine for hydrogen in DDC, as in the case of sodium bis(trifluoroethyl)dithiocarbamate (FDDC), can generally enhance the volatility and thermal stability of the resulting metal chelates. An inventibility and the case of thermal stability of the resulting metal chelates. An investigation on the characterization and GC separation of As and other relevant metal-FDDC complexes and the potential applications of this method to arsenic speciation studies was conducted. The results of differential scanning calorimetry and thermal gravimetric analysis clearly demonstrated the greater thermal stability and volatility displayed by As(FDDC)3 relative to the analogous As(DDC)3. Arsenate in aqueous solutions can be quantitatively extracted with Na-FDDC into chlorform in the pH range 2-6 according to the exquantitatively exhausted with NaT-DD- into clino-roform in the pH range 2-6 according to the ex-periments performed. pH 3 was chosen as the standard condition for extracting As(FDDC)3 in the experiments. At this pH, other metal-FDDC complexes, including those of Zn, Ni, Hg, Pb, and Bi, can also be quantitatively extracted. The method was applied to arsenic speciation in a dep well water sample collected from the 'black-foot disease' area in southwest Taiwan. The results disease' area in southwest Taiwan. The results agree with those determined by the solvent extraction and neutron activation analysis method described in previous papers. (Agostine-PTT) W91-10894

SENSITIVE HIGH-PERFORMANCE LIQUID CHROMATOGRAPHIC ANALYSIS FOR TOXICOLOGICAL STUDIES WITH CARBARYL.

Virginia-Maryland Regional Coll. of Veterinary Medicine, Blacksburg, VA. Dept. of Biomedical

J. R. Strait, G. C. Thornwall, and M. Ehrich. Journal of Agricultural and Food Chemistry JAFCAU, Vol. 39, No. 4, p 710-713, April 1991. 4 fig, 1 tab, 12 ref.

Descriptors: \*Analytical methods, \*Carbaryl, \*Detection limits, \*High performance liquid chromatography, \*Pesticides, \*Pollutant identification, \*Toxicology, Carbamate pesticides, Chromatography, Degradation products, Liquid chromatography, Metabolites, Separation techniques, Water.

Chromatographic techniques are currently used for detection of carbaryl. A simple extraction followed by HPLC analysis on a highly efficient 3 micrometer column was developed that increased sensitivity for detection of carbaryl and metabolites to the picomole range. Carbaryl and its degradation products could be detected in water and serum at levels as low as 0.5 ng/mL ( or 5% full scale responses at 0.005 aufs) by hPLC analysis using a 3 micrometer C-18 Ultrasphere column on a Beckman HPLC System. Preparation included a single extraction with methanol after application of samples to 1.0 mL of C18 solid-phase extraction columns. Advantages of this method include high

sensitivity, analysis time of 10 min after a single extraction, and high recovery. Sensitivity was maintained whether the carbaryl or its degradation products or metabolites were provided in water or in serum. This HPLC method could be useful for toxicological studies in which detection of low concentrations of carbaryl were needed. (Author's abstract) W91-10920

ANALYSIS OF HALOGENATED ACETIC ACIDS IN DUTCH DRINKING WATER. Rijksinstituut voor de Volksgezondheid en Milieu-hygiene, Bilthoven (Netherlands). For primary bibliographic entry see Field 5F. W91-10938 W91-10938

PROSPECTING FOR ZONES OF CONTAMINATED GROUND-WATER DISCHARGE TO STREAMS USING BOTTOM-SEDIMENT GAS BURBLES

Geological Survey, Columbia, SC. Water Re-For primary bibliographic entry see Field 5B. W91-10951

CHARACTERISTICS OF RHODAMINE WT

AND FLUORESCEIN AS ADSORBING GROUND-WATER TRACERS.
Oklahoma Univ., Norman. School of Civil Engineering and Environmental Science.
For primary bibliographic entry see Field 5B.
W91-10952

METHOD FOR INSTALLING MINIATURE MULTILEVEL SAMPLING WELLS.
Wisconsin Univ.-Madison. Dept. of Soil Science.
W. Stites, and L. W. Chambers. Ground Water GRWAAP, Vol. 29, No. 3, p 430-432, May/June 1991. 1 fig, 1 tab, 7 ref.

Descriptors: \*Field tests, \*Shallow wells, \*Water sampling, \*Well construction, Drilling samples, Groundwater, Groundwater quality, On-site tests,

Groundwater tracer test studies or contamination studies frequently require the removal of small quantities of water from specific depths. However, the methods previously described all require a large borehole drilled by a hollow stem auger or casing driven by a cable tool, which requires access for trucks or heavy machinery. A method has been developed to install miniature multilevel groundwater sampling wells in shallow, unconsolidated aquifers at sites without truck access. A small hole is created by driving a steel pipe into the ground, serving as a temporary casing into which a bundle of flexible polyethylene tubing is inserted. The pipe is then withdrawn, leaving only the tubing (and a disposable metal point) in the ground. An advantage of these wells over the traditional bundle-type multilevels is that this type of installation causes minimal aquifer disturbance. Groundwater tracer test studies or contamination traditional bundle-type mutitievels is trait instype of installation causes minimal aquifer disturbance. Thus, miniature multilevels can be installed while a tracer test is in progress. Furthermore, only hand tools are needed in the field, and equipment and materials are easily obtained and inexpensive. The time required for installation is comparable to other methods. (Fish-PTT)
W91-10962

COMPARATIVE PHYSICO-CHEMICAL ANALYSIS OF DRINKING, GROUND AND INDUSTRIAL WASTE WATER OF JODHPUR. Jodhpur Univ. (India). Dept. of Chemistry. For primary bibliographic entry see Field 5B. W91-11083

ESTIMATION OF TRACE METALS LEVELS IN POWER AND INDUSTRIAL WASTE WATER OF JODHPUR BY DIFFERENTIAL PULSE ANODIC STRIPPING VOLTAM-METRY.

Jodhpur Univ. (India). R. C. Kapoor, K. C. K. Mathur, and P. Sharma.

#### Group 5A-Identification Of Pollutants

IN: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemi-sphere Publishing Corporation, New York. 1990. p 447-454. 3 fig. 2 tab, 16 ref.

Descriptors: \*Industrial wastes, \*Jodhpur, \*Pollut-ant identification, \*Trace metals, \*Voltammetry, \*Wastewater pollution, \*Water pollution sources, Differential pulse anodic stripping volt, India, Soil contamination, Toxicity, Water quality monitoring.

Jodhpur usually experiences shortages of water. Many industries have moved into the region. The effluents released by the factories are toxic and potentially harmful. The waste water flows in two open drains and spreads over the land outside the city. The concentration of some toxic metal ions in city. The concentration of some toxic metal ions in the industrial waste water and fly ash from power generation plant in Jodhpur has been estimated from differential pulse polarography for zinc, and differential pulse anodic stripping voltammetry for lead, cadmium and copper. Results indicate that he concentration of lead in both cases is high. The industrial waste is toxic, and contamination of the surrounding land by lead is possible. (See also W91-11066) (Brunone-PTT)

BEHAVIOR OF DOUBLE GEONET DRAIN-

Drexel Univ., Philadelphia, PA. Geosynthetic Research Inst.

seatch inst.
R. M. Koerner, and B. L. Hwu.
Available from the National Technical Information
Service, Springfield, VA. 22161, as PB90-140872.
Price codes: A02 in paper copy, A01 in microfiche.
Report No. EPA/600/J-89/131, 1989. 6p, 4 fig, 3
tab, 11 ref. EPA Grant CR-813953-0.

Descriptors: \*Drainage systems, \*Geonets, \*Geotextiles, \*Landfills, \*Leachates, \*Materials testing, \*Monitoring, \*Water pollution control, Flow profiles, Flow velocity, Membranes, Soil water.

Geonets have become a popular component of leak detection systems at surface impoundments, waste piles, landfills and heap leach systems. They pro-vide a reasonable alternative to gravel drainage designs which become costly when large quantities of leachate are anticipated. This paper examines the potential increase in in-plane flow by placing two layers of geonet materials atop one another. The increase in flow was measured for three differtwo layers of geonet materials atop one another. The increase in flow was measured for three different cross sections: geomembrane overlain double geonets overlain by geomembrane overlain by double geonets overlain by geotextile and sand; and, geomembrane overlain by geotextile and sand; and, geomembrane overlain by geotextile and clay. The effect of soil intrusion was studied on the applicable cross sections. Flow rate comparisons of the double geonet situation with a single geonet were made when used between two geomembranes and found that the normal pressure was critical in that flows were double at low pressures, but much less at high pressures. The normal compression test results gave insight into this behavior. At values of normal pressure > 10,000 lb/sq ft the upper and lower geonets reorient themselves and fold into one another resulting in only a modest improvement in a single geonet; s flow capability. The real benefit of the double geonet concept, however, was found to be when a geotextile with soil above it is used. With a single geonet, intrusion of the geotextile by the soil significantly decreases its flow capability. With the double geonet, the intrusion only occurs in the upper geonet, leaving the lower geonet completely available for flow. Effiflow capability. With the double geonet, the intrusion only occurs in the upper geonet, leaving the lower geonet completely available for flow. Efficiencies of the double geonet over the single geonet are an impressive 200 to 460 percent. This occurs at all normal pressure levels, although the higher efficiencies are at the lower normal pressure. Clearly, the double geonet scheme for increased geonet flow rate capability is a valid and creased geonet flow rate capability is a valid and worthwhile concept as long as the geonets do not reorient themselves and fold into one another. (Lantz-PTT) W91-11096

NEW DEVELOPMENTS IN SAMPLING SLUDGE TREATED SOILS. Water Research Centre, Medmenham (England).

Medmenham Lab Medmenham Lab.
J. E. Hall, and T. R. E. Thompson.
IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 504-507. 2 fig, 3 ref.

Descriptors: \*Europe, \*Heavy metals, \*Sludge disposal, \*Sludge utilization, \*Soil sampling, \*Wastewater treatment, Administrative regulations, Soil profiles, Water quality monitoring.

The European Community (EC) directive on the use of sludge on agricultural land requires member states to sample soils to a depth of 25 cm to states to sample soils to a depth of 25 cm to monitor heavy metal concentrations. Problems in-volved with this sampling include metal distribu-tion in the soil profile, soil sampling errors, the present inadequacy of mechanical soil samplers, and the difficulties in providing baseline data for this monitoring program. Many member states have to implement or change soil monitoring strat-egies. (See also W91-11115) (Brunone-PTT) W91-11158

CHEMICAL PROPERTIES OF SEWAGE SLUDGES PRODUCED IN THE VALENCIAN AREA (SPAIN).

Instituto Valenciano de Investigaciones Agrarias,

Instituto Valenciano de Investigaciones Agrarias, Valencia (Spain).

J. Roca, F. Pomares, and F. Tarazona.

IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 508-516. 6 tab, 6 ref.

Descriptors: \*Agriculture, \*Fertilizers, \*Heavy metals, \*Pollutant identification, \*Sludge disposal, \*Sludge utilization, \*Soil amendments, \*Spain, \*Wastewater treatment, Chemical properties, Chromium, Copper, Lead, Regulations, Soil chemistry, Soil contamination, Urban planning, Zinc.

The chemical characterization of sewage sludges used in agriculture as either as fertilizer or as a soil amendment is important in order to determine: amendment is important in order to determine: their suitability as agricultural soils, and the mini-mum concentrations needed for plant nutrition (to avoid eutrophication of lakes and rivers). Sewage sludge from sixteen municipal wastewater treat-ment plants located in the Valencian Region of ment plants located in the Valencian Region of Spain were analyzed periodically to verify suitability for agricultural use. The parameters studied included organic matter, fertilizer elements, salinity and heavy metals. The results obtained showed that most of the sewage sludges produced in the region are adequate for agricultural soils; however, in four out of sixteen sewage sludges the heavy metal contents of zinc, lead, copper, and chromium exceeded the Commission of European Communities (CEC) guidelines. The determination of the source of heavy metals which are polluting the sewage sludges and the prevention of their distribution into urban sewerage systems will allow a greater amount of sludge to be used for agriculture. (See also W91-1115) (Brunone-PTT)

USE OF 2,2-DIMETHOXYPROPANE FOR THE DIRECT GAS CHROMATOGRAPHIC-MASS SPECTROMETRIC DETERMINATION OF SOME ORGANIC COMPOUNDS IN WATER. Consiglio Nazionale delle Ricerche, Padua (Italy). Servizio di Sicurezza del Lavoro e Protezione

A. Sturaro, L. Doretti, and G. Parvoli. Analytica Chimica Acta ACACAM, Vol. 244, No. 1, p 9-13, March 1991. 1 fig, 3 tab, 8 ref.

Descriptors: \*Chemical analysis, \*Dimethoxypropane, \*Gas chromatography, \*Mass spectrometry, \*Organic compounds, \*Organic pesticides, \*Pollutant identification, \*Sample preparation, \*Water analysis, Analytical methods, Chemical reactions, Detection limits, Organic pollutants, Separation techniques.

The well known reaction between 2.2-dimethoxypropane (the dimethyl ketal of acetone) and water allows for the conversion of an aqueous into an organic solution ready to be injected directly into a

gas chromatographic-mass spectrometric (GC-MS) system. Only time, temperature and water/ketal ratio were the only parameters among those studratio were the only parameters among those studied which influence the equilibrium reaction. A temperature increase leads to a higher acetone conversion because the reaction is endothermic. Temperatures higher than 30 C cause negligible variations in the amount of acetone in the final mixture. Independently of the water/ketal ratio, the reaction reaches the equilibrium steady state after a short time (15 min) at the optimum temperature (30 C). If the amount of ketal in the water/ketal ratio is increased, there is a higher yield, but an excessively dilute sample is obtained. The reaction environment is not suitable for all compounds: acids, esters, alcohols, amines, ketones, and phenols tion environment is not suitable for all compounds: acids, esters, alcohols, amines, ketones, and phenols may react with methanol, acetone and ketal owing to Amberlyst being present as catalyst. This method is proposed for the GC-MS analysis of aqueous solutions containing hydrocarbons, halogenated hydrocarbons and ethers. Dichlobenil, chloroneb, gamma-hexachlorocyclohexane, chlorothalonil, fluorodifen, and 1,2-benzanthracene pesticide concentrations in water were determined using the present method. The detection limits for the pesticides examined were 0.15-0.70 mg/L, corresponding to an absolute amount of 20-90 picograms obtained with signal-to-noise ratio of 3 for the scanned peaks. (Geiger-PTT) the scanned peaks. (Geiger-PTT) W91-11245

DETERMINATION OF TRACE LEVELS OF SULPHATE IN WATER USING FLOW-INJECTION AND IN-LINE PRECONCENTRATION.

Tecator A.B., Hoganas (Sweden). For primary bibliographic entry see Field 2K.

ORGANOTIN STABILITY DURING STORAGE OF MARINE WATERS AND SEDIMENTS.

Bordeaux-1 Univ., Talence (France). Lab. de Photophysique et Photochimie Moleculaire. P. Quevauviller, and O. F. X. Donard.

Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 339, No. 1, p 6-14, January 1991. 8 fig, 8 tab, 21 ref.

Descriptors: \*Antifoulants, \*Marine sediments, \*Organotin compounds, \*Pollutant identification, \*Sample preservation, Atomic absorption spectrophotometry, Gas chromatography, Monobutyltin, Sample preparation, Seawater, Temperature, Tributyltin.

The stability, over 4 months, of organotin com Ine stability, over 4 months, of organotin compounds in seawater and sediments was studied in relation to sample preservation efficiency for later gas chromatography/atomic absorption spectrophotometry. Storage of filtered natural seawater in the dark, at pH 2, in pyrex glass bottles, is suitable to preserve the stability of tributyltin over 4 months both at 20-25 C and 4 C. The other butyltin compounds (mono-and di-butyltin) are stable at 4 C but display some losses at 25 C. A poor recovery C but display some losses at 25 C. A poor recovery of butyltins in turbid water hampered the assessment of the stability on a quantitative basis; however, it could be demonstrated on a qualitative basis that butyltin stability is uneasily achieved in water samples with high suspended matter. Wet storage and freezing preserved the tributyltin stability in sediments, as well as oven-drying (at 50 C), freeze-drying and air-drying. Mono-and di-butyltin were generally subject to changes during the storage of sediments using the different methods. (Author's abstract) W91-11255

CONTINUOUS FLOW THIN-LAYER HEAD-SPACE (TLHS) ANALYSIS. I. CONDUCTOME-TRIC DETERMINATION OF VOLATILE OR-GANIC HALOGENS (VOX) IN TAP WATER. Gdansk Technical Univ. (Poland). Inst. of Inorganic Chemistry, Technology and Corrosion. E. Kozlowski, E. Sienkowska-Zyskowska, and T.

Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 339, No. 1, p 19-25, January 1991. 5 fig, 5 tab, 36 ref. CPBP Grant 01.17.

#### Identification Of Pollutants-Group 5A

Descriptors: \*Conductivity, \*Halogenated organic compounds, \*Laboratory methods, \*Pollutant identification, \*Volatile organic compounds, \*Water analysis, \*Water quality management, Chemical analysis, Drinking water, Gas chromatography, Halogens, Mineralization, Organic compounds, Separation techniques, Sulfur, Water quality

A new method of continuous determination of A new method of continuous determination of volatile organohalogens in water is presented which is based on the thin layer headspace (TLHS) technique. Volatile analytes are isolated from the aqueous phase in a thermostatted spiral tube (TLHS column) where the sample flows in a form of a thin film countercurrently to a stream of purified air. The isolated compounds are mineralized in an empty quartz tube at 900 C, and the mineralization products are washed with triple distilled water. The conductivity of the wash solution tilled water. The conductivity of the wash solution is proportional to the VOX content. The detection is proportional to the VOX content. The detection limit is on the order of a few parts per billion. The effect of the possible interference by ammonia can be effectively removed by an ion exchange column. The effect of sulfur can be eliminated by an application of a substance binding sulfur oxides an application of a substance binding sulfur oxides and being inert toward hydrogen halides such as magnesium oxide. The method was applied to the continuous determination of organohalides in tap water. At a 95% confidence level, the relative error of the method did not exceed 6%. (Author's

FLOW-RATE VARIATED HPLC-/EC-DETER-MINATION OF PHENOLS, Karl-Marx-Univ., Leipzig (German D.R.). Dept.

KALI-PUNIC, Leipzig (German D.R.). Dept. of Chemistry.

A. Hagen, J. Mattusch, and G. Werner.

Fresenius Zeitschrift fuer Analytische Chemie

ZACFAU, Vol. 339, No. 1, p 26-29, January 1991.

7 fig, 2 tab, 17 ref.

Descriptors: \*High performance liquid chromatography, \*Phenols, \*Pollutant identification, \*Wastewater analysis, \*Water analysis, Chemical analysis, Electrochemistry, Germany, Pleisse

A high performance liquid chromatogrpahy electrochemical method is proposed for the determination of phenol, alkylphenols, hydroxyphenols and chlorophenols. With the application of programmed flow-rate variation good resolution within short analysis times could be reached; the eluent is usable for several runs. An electrochemical dual detector provides detection limits ranging cal dual-detector provides detection limits ranging cal dual-detector provides detection limits ranging from 55 picograms for hydroquinone to 19 nano-grams for pentachlorophenol (injection volume 20 microliters). The dual mode is used to increase selectivity and sensitivity. The method was suc-cessfully applied to the direct determination of phenols in waste and river water. Phenol concentrations in wastewater from a coal manufacturing plant ranged from 0.72 to 9.64 mg/L and in Pleisse River water from 13 to 368 micrograms/L. (Author's abstract)
W91-11257

CAPILLARY COLUMN GAS CHROMATOGRA-PHY WITH NITROGEN-PHOSPHORUS DE-TECTION FOR DETERMINATION OF NITRO-GEN-AND PHOSPHORUS-CONTAINING PES-TICIDES IN FINISHED DRINKING WATERS:

TICIDES IN FINISHED DRINKING WATERS COLLABORATIVE STUDY.
Bionetics Corp., Cincinnati, OH.
K. W. Edgell, E. L. Jenkins, V. Lopez-Avila, and
J. E. Longbottom.

Journal - Association of Official Analytical Chemists JANCA2, Vol. 74, No. 2, p 295-309, March/ April 1991. 3 tab, 9 ref.

Descriptors: \*Drinking water, \*Gas chromatography, \*Pesticides, \*Pollutant identification, \*Water analysis, Herbicides, Laboratory methods, Nitrogen. Phosphorus.

A joint U. S. Environmental Protection Agency/ Association of Official Analytical Chemists (AOAC) Interlaboratory method validation study was conducted on EPA Method 507, Determina-

tion of Nitrogen-and Phosphorus-Containing Pesticides in Finished Drinking Water by Gas Chromatography with a Nitrogen-Phosphorus Detector, to tography with a Nitrogen-Phosphorus Detector, to determine the mean recovery and precision for analyses of 45 nitrogen-or phosphorus-containing pesticides in reagent water and finished drinking waters. The study design was based on Youden's nonreplicate plan for collaborative tests of analyti-cal methods. The waters were spiked with 45 nitrogen-or phosphorus-containing pesticides at 6 concentration levels, prepared as 3 Youden pairs. Ten volunteer laboratories extracted the spiked test waters with methylene chloride, performed a solvent exchange with methyl tert-butyl ether, and analyzed an aliquot of each extract by gas chromaanalyzed an aliquot of each extract by gas chroma-tography using a nitrogen-phosphorus detector. Results were analyzed using an EPA computer program, which measured recovery and precision for each of the 45 pesticides and compared the performance of the method between water types. Method 507 was judged acceptable for all analytes section 307 was juuged acceptable for all analytes tested except merphos, which thermally decomposed in the injection port of the gas chromatograph. Five compounds (carboxin, disulfoton, metolaclor, pronamide, and simazine) exhibited statistically significant matrix effects for the finished drinking water. The method has been adopted drinking water. The method has been adopted official first action by AOAC. (Author's abstract) W91-11259

DIRECT AQUEOUS INJECTION-LIQUID CHROMATOGRAPHY WITH POST-COLUMN DERIVATIZATION FOR DETERMINATION OF N-METHYLCARBAMOYLOXIMES AND N-METHYLCARBAMATES DRINKING WATER: IN FINISHED COLLABORATIVE DRINKING

STUDY.
Bionetics Corp., Cincinnati, OH.
K. W. Edgell, L. A. Biederman, and J. E.

Longoctom. Journal - Association of Official Analytical Chemists JANCA2, Vol. 74, No. 2, p 309-317, March/April 1991. 3 tab, 9 ref.

Descriptors: \*Carbamate pesticides, \*Drinking water, \*High performance liquid chromatography. \*Pollutant identification, \*Water analysis, Aldicarb, Carbaryl, Carbofuran, Laboratory methods,

An Interlaboratory method validation study was conducted on EPA Method 531.1, Measurement of N-Methylcarbamoyl-oximes and N-Methylcarbamoyl-oximes and N-Methylcarbamates in Water by Direct Aqueous Injection high performance liquid chromatography (HPLC) with Post Column Derivatization, to determine the precision and mean recovery for determination of 10 carbamate pesticide compounds in reagent water and in finished drinking waters. The study design was based on Youden's nonreplicate plan for collaborative tests of analytical methods. The waters were spiked with 10 carbamate pesticides at 6 were spiked with 10 carbamate pesticides at 6 concentration levels, as 3 Youden pairs. Eight labconcentration levels, as 3 Youden pairs. Eight laboratories analyzed the samples by direct aqueous injection, with separation by reverse-phase liquid chromatography and post-column hydrolysis of the carbamates and carbamoyloximes to methylamine, followed by reaction of the methylamine with ortho-phthalaldehyde and 2-mercaptoethanol using fluorescence detection. Results were analyzed using an EPA computer program, which measured precision and recovery for each of the locomounds and compared the performance of the measured precision and recovery for each of the 10 compounds and compared the performance of the method between water types. The method was acceptable for all analytes tested. After removal of a nonrepresentative data set for aldicarb sulfoxide, no matrix effects were observed; the statistics for the pooled drinking waters were not significantly different from the statistics for the reagent waters. The method has been adopted official first action by the Association of Official Analytical Chemists. (Author's abstract) (Author's abstract) W91-11260

LIQUID CHROMATOGRAPHIC DETERMINA-TION OF GLYPHOSATE AND AMINOMETH-YLPHOSPHONIC ACID (AMPA) IN ENVI-RONMENTAL WATER: COLLABORATIVE STUDY.

Monsanto Agricultural Co., St. Louis, MO. M. E. Oppenhuizen, and J. E. Cowell.

Journal - Association of Official Analytical Chemists JANCA2, Vol. 74, No. 2, p 317-323, March/April 1991. 4 fig, 3 tab, 11 ref.

Descriptors: \*Glyphosate, \*Herbicides, \*Liquid chromatography, \*Pollutant identification, \*Water analysis, Detection limits, Laboratory methods,

A new method for determination of glyphosate and amino-methylphosphonic acid (AMPA) residues in environmental water was collaboratively studied by 6 laboratories. The method is simpler and shorter than previous methods. A filtered volume of water is evaporated to dryness and the residue is dissolved in a buffered EDTA solution. residue is dissolved in a bullered EDTA solution. Glyphosate and AMPA are determined by liquid chromatography with postcolumn reaction detection. The method was validated over the range 0.50-5000 parts per billion (ppb), although one of the collaborating laboratories could not reliably quantitate below 1.0 ppb. Statistical analysis of the results showed that trigical reproducibility relative quantitate below 1.0 ppb. Statistical analysis of the results showed that typical reproducibility relative standard deviations (RSDr) ranged from 11 to 20% for both glyphosate and AMPA, which compares very well with predicted values for this concentration range. Total variability increased with increasing fortification level. The method has been adopted official first action by the Association of Official Analytical Chemists. (Author's absented) stract) W91-11261

DETERMINATION OF NITROAROMATICS AND NITRAMINES IN GROUND AND DRINK-ING WATER BY WIDE-BORE CAPILLARY GAS CHROMATOGRAPHY.

Army Environmental Hygiene Agency, Aberdeen Proving Ground, MD. Organic Environmental Chemistry Div. M. Hable, C. Stern, C. Asowata, and K. Williams.

Journal of Chromatographic Science JCHSBZ, Vol. 29, No. 4, p 131-135, April 1991. 5 fig, 3 tab,

Descriptors: \*Amines, \*Aromatic compounds, \*Drinking water, \*Gas chromatography, \*Pollutant identification, \*Water analysis, Detection limits, Laboratory methods, Nitrogen compounds.

A method was developed to determine the concentration of nitroaromatics and nitramines in drinking water at levels below those previously achieved by gas chromatography. The nitroaromatics and nitra-mines are extracted from water using toluene and mines are extracted from water using toluene and isoamyl acetale, respectively. The extracts are analyzed via a gas chromatograph equipped with a DB-1301 widebore fused-silica capillary column and an electron capture detector. Method detection limits of 0.003 micrograms/L for 2,6-dinitrotoluene, 0.04 micrograms/L for 2,4-dinitrotoluene, 0.06 micrograms/L for 2,4,6-trinitrotoluene, 0.3 micrograms/L for cyclotrimethylenetrinitramine, and 6.0 micrograms/L for cyclotetramethylenetetranitramine were obtained using this method. One of the benefits of using this method is that the use of small extraction volume generates a relatively small amount of hazardous waste. (Author's abstract) W91-11262

MARINE MONITORING IN HETEROGENE-OUS ENVIRONMENTS. EcoAnalysis, Inc., Ojai, CA

B. B. Bernstein, and J. Dorsey. Journal of Environmental Management JEVMAW, Vol. 32, No. 3, p 227-240, April 1991. 3 fig, 3 tab, 17 ref.

Descriptors: \*Los Angeles, \*Monitoring, \*Outfall sewers, \*Pollutant identification, \*Wastewater disposal, \*Water pollution effects, Biological samples, Biomass, California, Data processing, Environmental protection, Environmental quality, Species composition, Water pollution prevention.

Marine monitoring programs around the city of Los Angeles' Hyperion municipal wastewater out-fall provide insight into important issues in moni-toring design. Historical monitoring programs

### **Group 5A—Identification Of Pollutants**

have produced information that was instrumental in making major management decisions about waste treatment policies. Consistent data collection over time has helped document trends in environ-mental conditions around the outfall. Designing mental conditions around the outrail. Designing monitoring programs to meet present needs re-quires both consistency and adaptive flexibility. Consistency is needed to track trends over time and to compare data from several studies. Changing management concerns require adaptation and flexibility to natural conditions. Decreasing populations of ridgebacked prawn used in the monitoring of contaminant levels in invertebrates around the outfall areas has necessitated changing the target species to crabs. Unlike the shrimp, the crabs can be collected by transing instead of trawlcrabs can be collected by trapping instead of trawling which is more cost-effective and trapping is less destructive to the ocean floor. Flexibility in sampling the microlayer for contaminants is needed to sample inside or outside visible slicks. Microlayer monitoring has been developed by regulatory agencies and incorporated into the NPDES permit for Hyperion. Monitoring of the NPDES permit for Hyperion. Monitoring of the infaunal community structure and biomass in the vicinity of the outfall helps to detect improvements or degradations in the water quality. Better estimates of biomass variability at a station are obtained by averaging replicate samples than by relying on a single sample. Ophiuroid biomass should be estimated with a regression equation to reduce sample processing time. Since environmental heterogeneity can complicate detection and description of changes in infaunal communities near sewage outfalls, ordination analysis of community data directly rather than analysis of variance should be used for improved monitoring results. (Geiger-PTT) (Geiger-PTT) W91-11264

DEVELOPMENT OF AN ENZYME IMMUN-OASSAY FOR THE DETERMINATION OF METAZACHLOR.

Technische Univ. Muenchen, Freising (Germany, F.R.). Lehrstuhl fuer Botanik. H. M. Scholz, and B. Hock.

Analytical Letters ANALBP, Vol. 24, No. 3, p 413-427, March 1991. 4 fig, 2 tab, 20 ref. Deutsche Forschungsgemeinschaft Grant Ho 383/26-1.

Descriptors: \*Analytical methods, \*Enzymes, \*Herbicides, \*Immunoassay, \*Metazachlor, \*Pollutant identification, Monitoring, Rabbits, Water

Immunological methods have several advantages over the classical procedures, such as gas chromatography and high-performance liquid chromatography, because of their simplicity, high sample throughput, and lower reagent costs. A sensitive, solid phase microtiter plate enzyme immunosasy (ELISA) was developed for determination of the behalvide and to the close the solid phase the (ELISA) was developed for determination of the herbicide metazachlor, which belongs to the class of alpha-chloroacetamides. The antisera were raised in rabbits by immunization with a metazachlor-BSA conjugate containing 27 metazachlor residues per molecule. A competitive ELISA with a peroxidase-metazachlor tracer was performed. Metazachlor could be detected within the range 0.01-1 micrograms/L. This fulfills the requirements of the European Community guideline for pesticide concentrations of 0.1 micrograms/L in drinking water. The midpoint of the calibration curve was 0.09 micrograms/L and standard deviations were very low, with percentage coefficients of variability low, with percentage coefficients of variability ranging from 2 to 6%. The test showed no crossreactivity with other structurally similar chloroa-cetamide herbicides and little cross reactivity with derivatives of metazachlor. The derivatives metazachlor hydroxide, metazachlor carboxylic acid and metazachlor methyl carboxylate showed cross reactivities of 13, 2.8, and 4.5%, respectively. The cross reactivities of metazachlor analogues, such as alachlor, metolachlor and butachlor, was below 1%. None of the assayed structurally unrelated compounds, such as atrazine simazine, prometryne, terbutryne and methabenzthiazuron, were crossreactive. (VerNooy-PTT) W91-11295

NOAA SATELLITE DATA IN NATURAL OIL SLICK DETECTION, OTWAY BASIN, SOUTH-ERN AUSTRALIA.

W. J. Perry, P. E. Williamson, and C. J. Simpson. BMR Journal of Australian Geology & Geophys-ics BJAGDT, Vol. 12, No. 1, p 25-33, 1991. 12 fig,

Descriptors: \*Australia, \*Oil reservoirs, \*Oil slicks, \*Path of pollutants, \*Radiometry, \*Remote sensing, \*Satellite technology, \*Water pollution sources, Marine pollution, Monitoring, Oil fields,

Crude petroleum in the form of thick oil or bitu-Crude petroleum in the form of thick oil of bitu-men seeps in places from the sea floor off southeast South Australia, and periodically strands on the coasts of South Australia, western Victoria and western Tasmania. In this pilot study, National Oceanic and Atmospheric Administration (NOAA) Advanced Very High Resolution Radi-context data consisted by the NAAA 0 architic (NOAA) Advanced Very High Resolution Radi-ometer data acquired by the NOAA-9 satellite, during the period of 13 days before to 1 day after a reported stranding of 1000 tons on Kangaroo Island, was studied to try to detect the floating crude, map its drift path, and determine the loca-tion of the seepages. The study's failure to detect any oil slick on the ocean surface is attributed to the prevailing high percentage of cloud cover and any oil slick on the ocean surface is attributed to the prevailing high percentage of cloud cover, and the calculated small area occupied by the slick in relation to the spatial resolution of the sensor, particularly after the oil had been degraded to bitumen. In the study area, continuing monitoring of locations and timing of strandings and the asso-ciated meteorological conditions, are needed if the sites of oil seepage are to be determined. In such cloud-prone areas, monitoring of petroleum slicks by remote sensing could require sensors operating in the microwave part of the electromagnetic spec-trum, but in areas with clearer skies the use of NOAA satellite data should be further investigated. If the locations of oil seeps can be thus identified, they may define locations of petroleum fields. Consequently, this type of investigation may be a relatively inexpensive exploration method in some offshore areas. (Author's abstract) W91-11296

STANDARD TEST FISH FOR INDIA AND THE NEIGHBORING COUNTRIES.

Nagarjuna Univ., Nagarjunanagar (India). Dept. of

Nagariana
Zoology,
A. S. Murty, and K. Kondaiah.
Bulletin of Environmental Contamination and
Toxicology BECTA6, Vol. 46, No. 6, p 871-878,
June 1991. 2 tab, 16 ref.

Descriptors: \*Bioassay. \*Fish. \*Hazard assessment. \*India, \*Toxicity, \*Toxicology, \*Water pollution effects, Bioindicators, Median tolerance limit, Mortality, Sublethal effects, Testing procedures, Water quality criteria.

Among the battery of tests for environmental hazard evaluation of aquatic pollutants, the short-term or the 96-hour LC50 test with fish is one of term or the 90-nour LC30 test with itsn is one of the three base level aquatic toxicity tests that have to be conducted before registering a chemical for use in EEC (European Economic Community) countries. An evaluation was made of the suitabil-ity of some commonly occurring species of Indian fish for adoption as standard test fish for aquatic toxicity tests. The test fish (Danio devario (Hamiltoxicity tests. Ine test fish (Danio devarior (Hamilton), Esomus danricus (Hamilton), Chela atpar (Hamilton), Ambassis gymnocephalus Cuvier, Gambusia affinis (Baird and Girard), Puntius sofore (Hamilton), Oryzias melanostigma (McClelland), Aplocheilus panchax (Hamilton) and Puntius ticto (Hamilton) were collected from the Guntur canal or natural waterbodies around Nagarjuna University campus, Nagarjuna Nagar, South India. The calculated 96-hour LC50 of phenol for the nine species ranged from 5.6 to 30.6 mg/L. Five species were found to be unsuitable as standard test species were found to be unsuitable as standard test fish, due to non-uniform avoidance reactions and sensitivity to handling and acclimatization. The remaining four species, E. danricus, G. affinis, P. ticto and O. melanostigma, seem to be very well suited for being test fish as they could be easily transported to the laboratory, their mortality due to handling stress was negligible, no inexplicable control deaths were recorded, and the required age and size groups were available all through the year. Not only are the four species distributed all over the Indian subcontinent, but their distribution extends into neighboring Pakistan, Bangladesh, Nepal, Myanmar (Burma), Sri Lanka and Thai-land. (VerNooy-PTT) W91-11300

CONCENTRATION OF METALS IN VARIOUS LARVAL STAGES OF FOUR EPHEMEROP-TERA SPECIES.

Springborn Labs., Inc., Wareham, MA. For primary bibliographic entry see Field 5B. W91-11302

TOXICITY OF METALS TO A FRESHWATER TUBIFICID WORM, TUBIFEX TUBIFEX (MULLER).

Industrial Toxicology Research Centre, Lucknow (India). Preventive Toxicology Div. For primary bibliographic entry see Field 5C. W91-11303

PRECONCENTRATION OF HYDROPHILIC AND HYDROPHOBIC PESTICIDES FROM AQUEOUS SOLUTIONS AND EXTRACTION OF RESIDUES USING THE POLYMERIC SOR-BENT WOFATIT Y 77.

Akademie der Wissenschaften der DDR, Leipzig. Forschungsstelle fuer Chemische Toxikologie.

Forschungsstein tuer Chemische Toxikologie. W. Dedek, K. D. Wenzel, H. Oberlander, B. Mothes, and J. Mannig. Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 339, No. 4, p 201-206, February 1991. 7 tab, 16 ref.

Descriptors: \*Analytical methods, \*Chemical analysis, \*Pesticides, \*Pollutant identification, \*Proconcentration, \*Sorption, \*Water analysis, Gas chromatography, Herbicides, Insecticides, Pesticide residues, Plant tissues, Polymers, Radioactive tracers, Sediment analysis, Soil analysis, Thin layer chromatography.

Preconcentration of hydrophilic pesticides has been reported for the insecticides methamidophos, trichlorfon, dimethoate and the herbicides sodium trichloroacetate, fenuron, propachlor and 2,4-D. Meanwhile, the following compounds have been included in preconcentration experiments: dimethmetuded in preconcentration experiments dimensionation, methylparathion, bromophos, DDT, bromuron and lenacil from water in the concentration range between 0.05 micrograms/L and 1.0 mg/L; dimethoate and methamidophos from fruits and dimethoate and methamidophos from fruits and vegetables in the range of 0.2 mg/kg and dimethoate, propachlor and 2,4-D and a series of triazine, carbamate and urea herbicides from soils in the range of 0.2 to 1.0 mg/kg. The adsorption of dissociated compounds by polymeric sorbent Wofatit Y 77, depending on the pH intervals investigated, was effective for some compounds, but ineffective for ethephon, glyphosate, CCC and amirtole. Extraction of plant material using sodium chloride solution yielded recoveries of 65 to 95% of dimethoate, but for methamidophos, bound residues causing reduced recoveries have been obdues causing reduced recoveries have been ob-served. Optimal recoveries have been attained for extracting soils and sediments by mixtures of meth-anol or acetone with water. Studies were per-formed by using labelled compounds and thin-layer tornment by using latestier compounts and timi-ayer chromatography, whereas gas chromatography was effective for selected samples only, depending also on the type of detector used. (Author's abstract) W91-11305

COMPARISON OF AMPEROMETRIC AND UV-SPECTROPHOTOMETRIC MONITORING IN THE HPLC ANALYSIS OF PESTICIDES. Hunan Univ., Changsha (China). Dept. of Chemis-

try and Chemical Engineering. S. Yao, A. Meyer, and G. Henze.

Sresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 339, No. 4, p 207-211, February 1991. 7 fig, 14 ref.

Descriptors: \*Analytical methods, \*Chemical analysis, \*Electrochemistry, \*Liquid chromatography, \*Pesticides, \*Phenolic pesticides, \*Pollutant identification, \*Sensitivity analysis, \*Spectrophoto-

# Identification Of Pollutants—Group 5A

metry, \*Water analysis, Detection limits, Metabolites, Monitoring.

Development and selection of detectors with satisfactory performance for the high-performance liquid chromatography (HPLC) analysis of pesticides and their metabolites are of importance for cottes and their metaconites are of importance for controlling the legal limiting values in environmen-tal samples. Studies have been carried out to com-pare different detection techniques including am-perometric detection in the reductive and oxidative mode and ultraviolet (UV) detection following the HPLC sengration of pesticides. By the example of HPLC separation of pesticides. By the example of 4,6-dinitro-o-cresol (DNOC), 2-sec-butyl-4,6-dinitrophenol (Dinoseb) and 2-tert-butyl-4,6-dinitrophenol (Dinoterb), it was shown that electrochemical detection exhibits higher sensitivities than the UV technique. The detection limits were 0.1 ng for Ov technique. The detection limits were 0.1 ing for pesticides using the amperometric technique, and 0.3 ng for DNOC and 1 ng for Dinoseb and Dinoterb using the reductive mode. By UV monitoring, the detection limits were 2 ng for DNOC and 24 ng for Dinoseb and Dinoterb. Thus, the and 24 ng for Dinoseb and Dinotero. It nus, the electrochemical method was found to be 20 to 240 more times more sensitive than the UV method. Furthermore, the reproducibility of the electro-chemical method was also better than that of the UV method. (Author's abstract)

MULTI-RESIDUE-ANALYSIS OF PESTICIDES BY HPLC AFTER SOLID PHASE EXTRAC-TION.

er A.G., Gelsenkirchen (Germany,

C. Schlett.

C. Schiett. Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 339, No. 6, p 344-347, February 1991. 5 fig, 2 tab.

Descriptors: \*Analytical methods, \*Chemical analysis, \*Liquid chromatography, \*Pesticides, \*Pollutant identification, \*Separation techniques, \*Water analysis, Calibrations, Detection limits, Drinking water, Water quality monitoring.

In most countries of the European community, drinking water regulations set a limit of 0.1 microgram/L as the maximum level for individual pesticides and 0.5 microgram/L for the sum of all pesticides. To control and enforce legislation, a sensitive, universal and reliable analysis method is pesitiones. To control and reliable analysis method is required that can analyze a broad variety of substances in a single run. High-performance liquid chromatography (HPLC) has been found to be a good method for analyzing a broad variety of different pesticides in drinking and surface water. Since only a limited number of substances can be analyzed in a single run, one has to focus on the 20 to 30 compounds that are relevant in the water catchment area studied. Due to a high enrichment factor in solid phase extraction and the sensitive detection in the ultraviolet range, many pesticides can be determined even at a concentration lower than 0.05 micrograms/L. Use of a diode-array-detector enables acquisition of UV-spectra online and monitoring of signals for up to 8 wavelengths simultaneously. Thus for different classes of substances the best selectivity can be obtained by smuttaneously. Into for different classes of sub-stances the best selectivity can be obtained by choosing the appropriate wavelength with maxi-mum absorption. This aids in the identification of substances. In order to obtain the best quantitative accuracy each compound is calibrated at 5 levels from 0.025 to 1.000 micrograms/L. The detection limit is about 0.025 micrograms/L. (VerNooy-PTT) W91-11307

APPLICATION OF HPLC COLUMN-SWITCH-ING IN PESTICIDE RESIDUE ANALYSIS.

Rijksinstituut voor de Volksgezondheid en Milieu-hygiene, Bilthoven (Netherlands). E. A. Hogendoorn, C. E. Goewie, and P. van

Zoonen.

Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 339, No. 6, p 348-356, February 1991. 12 fig, 4 tab, 19 ref.

Descriptors: \*Analytical methods, \*Chemical analysis, \*Laboratory equipment, \*Liquid chromatography, \*Pesticide residues, \*Water analysis, Re-

views, Sediment analysis, Selectivity, Sensitivity

The application of high-performance liquid chromatography (HPLC) for residue analysis is growing, especially for the analysis of pesticides which cannot be analyzed directly by gas chromatography due to poor volatility, polarity, and/or thermal instability of the compounds. An overview is given of the applicability of HPLC with column-switching in pesticide residue analysis. The main advantage of HPLC with column-switching is the enhancement of both sensitivity and selectivity combined with a high potential for automation, such as automated cleanup of extracts prior to LC analysis. Using relatively short columns (15x3.2 mm ID) as the first C18 column (C-1), mixtures of moderately polar pesticides not differing too much in retention can be sensitively analyzed in difficult matrices. The use of longer (50x3.0 mm ID) C18 columns as C-1, offers the possibility to perform an effective on-line cleanup for the simultaneous analysis of pesticides with a larger difference in retention. For the analysis of a single polar compound with little C18 retention, the use of this longer first C18 column appears to be very successful with respect to selectivity. In this case, the system behaves as a true multi-dimensional chromatographic separation. For this survey, column-switching conditions were mostly found by means of trial-anderror experiments. In order to find optimal conditions more easily, a computer program has been developed for predicting accurate peak volumes error experiments. In order to find optimal condi-tions more easily, a computer program has been developed for predicting accurate peak volumes and retentions under column-switching conditions. The method has been applied successfully to the analysis of pesticide residues in drinking water and sediments. (VerNooy-PTT) W91-11308

MULTIMETHOD FOR PESTICIDES IN SOIL

AT TRACE LEVEL.
ESWE-Inst. fuer Wasserforschung und Wassertechnologie G.m.b.H., Wiesbaden (Germany,

F.K.). H. Weil, and K. Haberer. Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 339, No. 6, p 405-408, February 1991. 3 fig, 4 tab, 1 ref.

Descriptors: \*Analytical methods, \*Fate of pollutants, \*Gas chromatography, \*Mass spectrometry, \*Path of pollutants, \*Pesticides, \*Soil analysis, \*Trace levels, Fungicides, Germany, Groundwater pollution, Herbicides, Insecticides, Rhine River, Scil cost-principies. Soil contamination.

During the subsoil transport of pesticides, adsorp-tion processes on solid phases are primarily respon-sible for the removal of pesticides. The adsorbed pesticides represent a latent risk to groundwater if maximal adsorption is reached and pesticides will desorb. A multimethod has been developed for the determination of various pesticides in deep layers of soil which occurred permanently or sporadically in the Rhine River. The soil samples were taken from the areas of a surface water works in October 1989 and extracted by using a Soxhlet apparatus. Quantitative determination of several pesticides Quantitative determination of several pesticides and other compounds, including simazine, atrazine, Metolachlor, Propham, Furalaxyl, diethyltoluamide, and tributyl phosphate, was achieved by the gas chromatograph (GC) with N/P-detector. Positive results were confirmed by the GC with mass spectrometry detector. Despite many years of pollution of the Rhine with pesticides and other substances, no pesticides sorbed on soil particles of the infiltration area were detected. The possibility of desorption, which can occur because of reversible adsorption equilibria, has to be rejected. The dominant factor in the elimination of dissolved contaminant so in the elimination of dissolved contaminants is not desorption, but dispersion. This process leads to the spreading of substances as they move with the water, and results in dilution of contaminant peaks, and in the attenuation of concentration. The groundwater passage of pesticides in low concentrations does not suggest a latent in low concentrations does not suggest a latent risk. The investigated substances are relatively polar (high water solubility) and have little tenden-cy to sorb (low soil adsorption coefficients). Results of the analysis support these assumptions.

DETERMINATION OF HERBICIDE RESIDUES IN SOIL IN THE PRESENCE OF PER-SISTENT ORGANOCHLORINE INSECTI-

Plant Protection Inst., Sofia (Bulgaria). A. M. Balinova, and I. Balinov. Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 339, No. 6, p 409-412, February 1991. 1 fig, 4 tab, 10 ref.

Descriptors: \*Gas chromatography, \*Herbicides, \*Organochlorine pesticides, \*Pesticide residues, \*Pollutant identification, \*Separation techniques, \*Soil analysis, Analytical methods, DDT, Organic Soil contamination, Water

A rapid and reproducible gas-chromatographic method has been developed for determination of residues in soil of some widely used herbicides such as trifluralin, metribuzin, alachlor, acetochlor, metolachlor, pendimethalin, simazine, atrazine, prometryne, in the presence of persistent organ-ochlorine insecticides (p.p-DDT, o.p-DDT, p.p-DDE, alpha-HCH, gamma-HCH, heptachlor). De-termination of some herbicides by gas chromatotermination of some heroicities by gas chromato-graph (GC/electron-capture detector (ECD) is difficult since their relative retention times on packed columns usually used for pesticide analysis are equal or close to those of some persistent organochlorine insecticides which can still be found almost everywhere, especially in cultivated soils. A 1.8 m column of 3% OV-225 + 5% SE-52 in a ratio of 1.4 to 0.9 gave good separation of all herbicides and insecticides mentioned. An examination was made of the influence of 6 solvents and nation was made of the influence of a solvents and solvent systems applied most frequently for soil extraction of pesticide residues on recovery of the compounds under study. Acetonitrile was the most suitable extractant as it rendered the highest residue recoveries and minimal amount of co-extrac-tives. Residues of simazine, atrazine, and prometryne were determined in the same extracts by the use of NP-detector and a column of 5% Carbowax 20M. Recoveries of the compounds under study were in the range 86%-103% without cleanup and were in the range 80%-103% without creanup and 78%-94% when cleanup was carried out. The method can be used in pesticide monitoring of soil as it offers an opportunity for rapid determination of soil applied herbicides and persistent organochlorine insecticides which are some of the most common pollutants in cultivated soils. (Author's abstract) abstract) W91-11310

# ANALYSIS OF 10 SELECTED HERBICIDES IN WATER.

J. Legler.

Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 339, No. 6, p 417-419, February 1991. 1 fig, 1 tab, 3 ref.

Descriptors: \*Analytical methods, \*Chemical analysis, \*Drinking water, \*Herbicides, \*Pollutant identification, \*Separation techniques, \*Water analysis, Chromatography, Gas chromatography, Germany, Laboratory methods, Liquid chromatography, Thin layer chromatography.

Since October 1, 1989, the German maximum res Since October 1, 1989, the German maximum residue level for each pesticide in drinking water is 0.1 micrograms/L, while the corresponding value for the total amount of all pesticides is 0.5 microgram/L. In three collaborative studies a method for the determination of pesticides in drinking water has been tested. For these studies 10 herbicides were chosen: atrazine, simazine, terbutylazine, cyana-zine, isoproturon, hexazinon, methabenzthiazuron, bromacil, dichloroprop, and mecoprop. They were chosen both because of their frequent application and their different chemical structures. For the and their different chemical structures. To the enrichment by solid phase extraction, surface modified silica gel was used by all participants, while for determination in the eluates, different methods of measurement were chosen, according to the available equipment of the analyst. Not all of the 10 spiked herbicides could be measured in the the to spiked neroscues could be measured in the eluates by all of the 13 participants of this study. Each participant used either capillary-gas chroma-tography (GC), high-pressure liquid chromatogra-phy (HPLC) or thin-layer chromatography (TLC).

#### Group 5A-Identification Of Pollutants

Analysis of the herbicides was achieved even at concentrations of 50 ng/L. Average recoveries were between 72% and 115%, with a relative standard deviation of about 21%. Gas chromatogstandard deviation of about 21%. Gas chromatog-raphy with a nitrogen-phosphorus sensitive detec-tor, a mass-selective detector, and an electron-capture detector is suitable for the analysis of triazines and other substances. Liquid chromatog-raphy (HPLC and TLC-AMD) is more suitable for the analysis of some polar or thermic unstable substances. So confirmation of one analytical result substances. So confirmation of one analytical result with a second independent measurement (for instance GC and HPLC) may be successful. An additional 70 pesticides were analyzed by participants of these studies. (VerNooy-PTT) W91-11311

STRATEGY FOR PESTICIDE CONTROL IN GROUND WATER AND DRINKING WATER. GROUND WATER AND DRINKING WATER. Karlsruhe Univ. (Germany, F.R.). DVG-Forschungsstelle am Engler-Bunte-Inst. H. J. Brauch, and S. Schullerer. Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 339, No. 6, p 420-422, February 1991. 5 fig, 9 ref.

Descriptors: \*Analytical methods, \*Chemical analysis, \*Drinking water, \*Groundwater pollution, \*Monitoring, \*Pesticides, \*Pollutant identification, \*Water analysis, Chromatography, Reviews, Separation techniques

Pesticide analysis in water is done by quantitative determination of individual compounds. Qualified methods like high resolution gas chromatography (HRGC), high performance liquid chromatography (HPLC), and thin layer chromatography (TLC) with excellent detectors are available. In some cases screening methods are used for groundwater control. With screening methods, carried out by special GC or HPLC methods, only qualitative results can be obtained. To get quantitative results, comparison of retention times and recoveries with standards is necessary. A useful monitoring strate-gy that can be carried out by quantitative determination has to include all important pesticides, such as atrazine, simazine, isoproturon, chlorotoluron, bentazone, and mecoprop. Since pesticides have different chemical properties, multi-methods have been developed, which allow the measurement of 'similar' substances. The use of a mass spectrome-ter or a mass selective detector is recommended, and identification of pesticides by ultraviolet (UV) spectra is possible using a diode array detector (DAD). It has been found that recoveries of the analyzed pesticides have to be controlled from time to time, and some extremely polar pesticides such as Amitrole, Glyphosate, etc. have not yet been successfully analyzed by multi-methods. (VerNooy-PTT) W91-11312

SOLID-PHASE EXTRACTION FOR MULTI-RESIDUE ANALYSIS OF SOME TRIAZOLE AND PYRIMIDINE PESTICIDES IN WATER, mperial Chemical Industries Ltd., Bracknell (Eng-and). Plant Protection Div.

Baldy, Flaint Protection Div. E. Bolygo, and N. C. Atreya. Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 339, No. 6, p 423-430, February 1991. 8 fig, 2 tab, 9 ref.

Descriptors: \*Analytical methods, \*Chemical analysis, \*Groundwater pollution, \*Pesticide residues, \*Pollutant identification, \*Separation techniques, \*Triazine pesticides, \*Water analysis, Detection limits, Gas liquid chromatography, Liquid chromatography, Pesticides.

A multi-residue analytical method based on solidphase extraction (C18) has been developed for the analysis of 12 compounds in groundwater. These compounds are triazoles, e.g., diclobutrazol, flu-triafol, hexaconazole, paclobutrazol and its ketone triatol, nexaconazole, pactooutrazol and its ketone analogue and pyrimidines, e.g., bupirimate, pirimicarb, pirimiphos-methyl, ethirimol, and other pesticides: fluazifop-P-butyl, fluazifop and fomesafen. One liter of water modified with 1% methanol was extracted using a C18 solid-phase extraction column, containing 1 g of adsorbent. The retained compounds were eluted from the column with

accessive elutions of acetonitrile and methanol. No further cleanup was necessary. Residues were determined either by capillary gas-liquid chromatography (GLC) using a nitrogen-phosphorus selective detector, or high performance liquid chromatography (GLC) using a UV detector. Recovery data on these compounds were obtained by fortifying water at 0.05 to 100 microgram/L levels. Depending on the compound, mean recoveries were within the range of 80% to 107% with a coefficient of variation of 9% to 15%. The limit of determination, defined as four times the baseline noise, varied between 0.003 to 0.1 microgram/L also depending on the compound and detection sensitivity of the instrument. These recovery data have also been compared to values generated by conventional liquid-liquid partition. Various techniques were used to confirm the identity of these compounds. Gas chromatography-mass spectrometry (GC-MS) using selective ion monitoring (SIM) was used to confirm the compounds which were amenable to gas-liquid chromatography. These No further cleanup was necessary. Residues were was used to confirm the compounds which were amenable to gas-liquid chromatography. These were all the triazoles and bupirimate, pirimicarb, pirimiphos-methyl and fluazifop-P-butyl. HPLC methods were developed using different mobile phase and adsorbent combinations for the confirmation of ethirimol, fluazifop and fomesafen residues in water. (Author's abstract) W91-11313

SIMPLE SPECTROPHOTOMETRIC DETER-MINATION OF ENDOSULFAN IN RIVER WATER AND SOIL. Ravishankar Univ., Raipur (India). Dept. of Chem-

istry. J. Raju, and V. K. Gupta. Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 339, No. 6, p 431-433, February 1991. 1 fig, 1 tab, 12 ref.

Descriptors: \*Analytical methods, \*Chemical analysis, \*Endosulfan, \*Insecticides, \*Pesticides, \*Polutant identification, \*Soil analysis, \*Spectrophotometry, \*Water analysis, Adsorption, Chlorinated hydrocarbon insecticides.

Endosulfan (Thiodan), a broad spectrum chlorinat-ed insecticide containing sulfur, is used against many types of insect pests of plants and vegetables. A simple spectrophotometric determination of en-dosulfan is based on the liberation of sulfur dioxide dosuman is obsect on the floreration of stiff disorbed into an adsorbing reagent, malonyldihydrazide (MDH) and estimated by using p-amino azobenzene and formaldehyde to give a pink colored dye which has an absorbance maxima at 505 nm. Beer's Law is obeyed in the range of 1 to 6 ppm for a standard solution of endosulfan. The method can be easily applied in river water and soil samples to determine endosulfan levels as low as 0.5 ppm and 0.25 ppm in river water and soil, respectively. The method is free from the interference of most of the commonly used pesticides and foreign ions. Other organochlorine pesticides, organophosphorus pesticides, carbamates, ammonia, phenol, nitrate and phosphate do not interfere with the reaction. Aramite and other sulfur containing compounds, which easily liberate sulfur dioxide interfere with which easily liberate sulfur dioxide interfere with the reaction. The major advantages of the pro-posed method over the available spectrophotome-tric methods are the use of a simple apparatus for the liberation/absorption of sulfur dioxide, and the use of MDH (in place of glycerol-alkali) as an absorbing solution which has about 100% absorp-tion efficiency. (Author's abstract) W91-11314 W91-11314

BEHAVIOR OF THE FUNGICIDE MBAMT IN WATER.

WATER.
Zhejiang Agricultural Univ., Hangzhou (China).
Dept. of Plant Protection.
D. F. Fan, and X. L. Chen.
Fresenius Zeitschrift fuer Analytische Chemie
ZACFAU, Vol. 339, No. 6, p 434-435, February
1991 4 fig. 4 teb. Se 1991. 4 fig, 4 tab, 5 ref.

Descriptors: \*Analytical methods, \*Chemical analysis, \*Degradation products, \*Fate of pollutants, \*Fungicides, \*Liquid chromatography, \*Pesticide residues, \*Photolysis, \*Water analysis, Chemical degradation, China, Hydrolysis, Pollutant identification.

MBAMT (N,N-methylene-bis(2-amino-5-mercapto-1,3,4-thiadiazole) is a new fungicide which is used to control rice bacterial leaf blight in China. A reversed-phase HPLC method is described for the determination of the fungicide MBAMT and its degradation product 2-amino-5-mercapto-1,3,4-thiadiazole (AMT) in water. The recoveries of the method for MBAMT and AMT lie between 90 +/-2.2% and 94.2 +/-2.2%; the theoretical detection limits for MBAMT and AMT in 100 mL samples are 2 ppb and 0.8 ppb, respectively. Column efficiency and detection sensitivity of this reversed-phase chromatographic method are better than methods using normal-phase modes. Hydrolysis and photodegradation studies of MBAMT in water were done in laboratory and field experisis and photodegradation studies of mPAM1 in water were done in laboratory and field experiments. The results from a model test-solution indicate that the degradation of MBAMT in water solutions of different ph values is very fast. These results agree with field test values, indicating that photodegradation is the main factor for MBAMT decomposition in the field and hydrolysis is of decomposition in the fleat and hydroysis is of minor importance. It is concluded that when used in conventional dosage, MBAMT, which is used in paddy fields in the south of China, should not be a hazard to the aquatic fauna and environment. (Ver-Noov-PTT)

NEW STANDARDS FOR THE DETERMINA-TION OF GEOSMIN AND METHYLISOBOR-NEOL IN WATER BY GAS CHROMATOGRA-PHY/MASS SPECTROSCOPY.

Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water

W. Korth, K. Bowmer, and J. Ellis. Water Research WATRAG, Vol. 25, No. 3, p 319-324, March 1991. 3 fig, 3 tab, 16 ref.

Descriptors: \*Analytical methods, water, \*Measuring instruments, \*Odors, \*Radio-chemical analysis, \*Water analysis, \*Water quality monitoring, Deuterium, Gas chromatography, Mass spectrometry, Odor-producing algae, Stand-

Geosmin and methylisoborneol (MIB) are secondary metabolites of certain blue-green algae and actinomycetes that impart an earthy or musty odor to drinking water. Their odor threshold concentrations are 10-20 ng/L. As a consequence only the most sensitive methods will suffice for their analysis. Deuterium labelled geosmin and MIB have been synthesized and evaluated as internal standss. Deuterium incented geosmin and with nave been synthesized and evaluated as internal stand-ards in the determination of geosmin and MIB in water by closed loop stripping followed by gas chromatography/mass spectrometry (GC/MS). The labelled standards were compared with chlor oalkanes added at sampling time, the new standoalkanes added at sampling time, the new standards enabled accurate determination of the geosmin and MIB present initially, even when the samples were analyzed as much as three weeks later. The new standards gave better precision and accuracy than the chloroalkanes and overcame the underestimation of initial analyte concentration which usually results from losses of analyte through adsorption, volatilization, biodegradation, etc. during sample storage. Geosmin had a limit of detection of < 0.1 ng/L and 1 ng/L was determined with a coefficient of variation (CV) of 1.2% (n=5). MIB was determined at 1 ng/L with a CV (n=5). MIB was determined at 1 ng/L with a CV of 3.5% (n=5). Deuterium labelled standards offer many advantages over conventional internal stand-ards used for the determination of MIB and geosards used for the determination of MID and geos-min. They offer precision and accuracy at concen-trations below the threshold odor concentration, compensation for analyte loss during sample stor-age, and save time. The method could also be used to determine MIB and geosmin in food and beverages. (Doyle-PTT) W91-11329

GAMMARUS: ASELLUS RATIO AS AN INDEX OF ORGANIC POLLUTION.

Brighton Polytechnic (England). Dept. of Civil Engineering. I. T. Whitehurst.

Water Research WATRAG, Vol. 25, No. 3, p 333-339, March 1991. 8 tab, 16 ref.

## Identification Of Pollutants—Group 5A

Descriptors: \*Amphipods, \*Bioindicators, \*Isopods, \*Stream pollution, \*Water pollution effects, \*Water quality monitoring, Aquatic ecosystems, Nitrates, Nitrites, Organic pollutants, Phosphates, Pollution index, Riffle beetles, Riffles.

Gammarus pulex normally inhabits the well oxygenated riffle reaches of the river bed living between stones and is generally intolerant of organic pollution. Asellus aquaticus, however, is not normally considered to be a member of the riffle community but is usually found in the depositing substratum of pools. Asellus invades the modified riffle ecosystem as a part of the replacement community during organic enrichment and often becomes dominant. Large numbers of Asellus in the riffles therefore, are considered to be an indication of organic pollution. Macroinvertebrate populations including Gammarus pulex and Asellus aquaticus were surveyed at riffle sites on four lowland rivers, i.e. the Rivers Adur and Ouse and the Chess Stream, Sussex and the Eridge Stream, Kent. Sites were situated both upstream and downstream of sewage treatment works. Macroinvertebrates were collected using a Surber sampler and at some sites the water was analyzed for the main chemical constituents. Poor water quality is characteristically associated with low biotic scores and in this respect the Gammarus: Asellus ratio applied to riffle data corresponded with the Chandler Biotic Score Index and the Extended Trent Biotic Index. The Gammarus: Asellus ratio showed the closest correlations with concentrations of BOD, ammonia-nitrogen (NH3-N), nitrite-nitrogen (NO2-N) and phosphate-phosphorus (PO4-P) being sensitive to changes in water quality brought about by organic enrichment in the four rivers investigated. It is proposed that the Gammarus: Asellus ratio may provide a simple biological tool which could be used by anglers and other non-professional river users to routinely monitor water quality. (Doyle-PTT)

COLIPHAGE AND BACTERIOPHAGE AS INDICATORS OF RECREATIONAL WATER

Ontario Ministry of the Environment, London. Technical Support Section.

G. A. Palmateer, B. J. Dutka, E. M. Janzen, S. M. Meissner, and M. G. Sakellaris.

Water Research WATRAG, Vol. 25, No. 3, p 355-357, March 1991. 2 tab, 17 ref.

Descriptors: \*Bacteriophage, \*Beach contamination, \*Bioindicators, \*Enteroviruses, \*Water analysis, \*Water quality monitoring, Analytical methods, Canada, Culturing techniques, Public health, Recreation facilities, Risk assessment.

In the past few years, the presence of enteric viruses has been noted in water quality studies of some Canadian bathing beaches. No correlation was found between the presence of these viruses and the fecal indicator bacteria. A correlation between the presence of of oliphage or other bacteriophage and enteric viruses has been indicated in recent studies. In particular, a single stranded RNA phage may serve the need to develop a more reliable and economical indicator for detecting public health risks from human enteric viruses. Five popular beaches in Southwestern Ontario, Canada, were investigated for the presence of coliphage, bacteriophage and the standard bacterial indicators of fecal waste. Using current phage enumeration techniques, both coliphage and bacteriophage were recovered at all five beaches on each of ten sampling trips. Coliphage and bacteriophage results were available in 6 to 18 h, respectively. The fecal coliforms required an incubation period of 24 hours. Based on recent reports on the association of coliphage and bacteriophage with enteroviruses in surface waters, and the consistent occurrence of both coliphage and bacteriophage at the five beaches investigated, future studies on the determination of health risks related to bathers, should involve virological analyses including the enumeration of coliphage and bacteriophage as part of the continuing evaluation of fecal pollution impacts on recreational waters. (Doyle-PTT)

METHYL AND BUTYLTIN COMPOUNDS IN WATER AND SEDIMENTS OF THE RHINE RIVER.

Max-Planck-Inst. fuer Chemie, Mainz (Germany, F.R.). Biogeochemistry Dept.
For primary bibliographic entry see Field 5B.

QUANTITATIVE DETERMINATION OF ACRYLONITRILE IN AN INDUSTRIAL EFFLUENT BY AMBIENT-TEMPERATURE PURGE AND TRAP CAPILLARY GC-MS AND BY HEATED PURGE AND TRAP GC-FID.

Air Products and Chemicals, Inc., Trexlertown, PA.

D. L. Vassilaros, T. J. Bzik, and C. A. Cara. Environmental Science and Technology ESTHAG, Vol. 25, No. 5, p 878-883, May 1991. 3 fig. 3 tab. 6 ref.

Descriptors: \*Acrylonitrile, \*Analytical techniques, \*Nitrogen compounds, \*Pollutant identification, \*Priority pollutants, \*Quantitative analysis, \*Wastewater analysis, Effluents, Experimental data, Gas chromatography, Mass spectrometry, Statistical analysis.

The commitment of regulatory agencies to minimize exposure to acrylonitrile (AN) has prompted the development of analytical methods to determine AN in water. The Environmental Protection Agency (EPA) has developed priority pollutant methods which are designed to analyze aqueous waste streams. EPA method 603 was specifically developed for the determination of AN and requires a heated purge cell, a packed column, and flame ionization detection. Another EPA priority method that may be useful for the detection of AN requires an ambient-temperature purge cell, a packed column, an internal standard, and mass spectrometric detection of the analytes (EPA method 624). The application of EPA method 603 to the routine determination of AN was evaluated for a specific waste effluent. This wastewater contained a complex mixture of nitrogen-substituted and oxygen-substituted aliphatic and alicyclic hydrocarbons. The effluent's chemical composition was significantly different from the effluent used in the laboratory evaluation of method 603. The consequent matrix effects forced fundamental modification of 603 instrumentation. The samples were then analyzed by a modified 624 method using capillary gas chromatography-mass spectrometry (GC-MS) and an ambient-temperature purge cell. Method validation data and a statistical analysis of data from calibration standard solutions analyzed over a 6-month period showed that the method was linear and had good sensitivity. The method precision determined from a series of standards yielded a 1 sigma relative standard deviation of 22%. (Korn-PT)

MAJOR INCIDENT OF DIOXIN CONTAMINA-TION: SEDIMENTS OF NEW JERSEY ESTU-ARIES

Lamont-Doherty Geological Observatory, Palisades, NY.

For primary bibliographic entry see Field 5B. W91-11341

PHENYLTINS IN WATER, SEDIMENT, AND BIOTA OF FRESHWATER MARINAS.

Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).

For primary bibliographic entry see Field 5B. W91-11342

USE OF A SINGLE-BOWL CONTINUOUS-FLOW CENTRIFUGE FOR DEWATERING SUSPENDED SEDIMENTS: EFFECT ON SEDI-MENT PHYSICAL AND CHEMICAL CHARAC-TERISTICS,

Geological Survey, San Diego, CA. For primary bibliographic entry see Field 7B. W91-11350 RELATIONSHIP OF MSS AND TM DIGITAL DATA WITH SUSPENDED SEDIMENTS, CHLOROPHYLL, AND TEMPERATURE IN MOON LAKE, MISSISSIPPI.

Agricultural Research Service, Beltsville, MD.
Hydrology Lab.
For primary hibliographic entry see Field 7C

For primary bibliographic entry see Field 7C. W91-11354

LOW COST FLOW INJECTION ANALYSIS FOR CADMIUM USING 2-(2-BENZOTHIAZO-LYLAZO) -4,5-DIMETHYLPHENOL.

Chiang Mai Univ. (Thailand). Dept. of Chemistry. K. Grudpan, and C. Paisaludomsil. Journal of Environmental Science and Health (A) JSSEDU, Vol. 26, No. 1, p 63-74, 1991. 9 fig, 2 tab, 23 ref.

Descriptors: \*Analytical methods, \*Cadmium, \*Chemical analysis, \*Heavy metals, \*Pollutant identification, \*Trace metals, \*Water analysis, Flow injection analysis, Instrumentation, Water quality monitoring.

Cadmium has become of great interest in various aspects of environmental studies because of its toxicity. A simple and rapid, but reliable method for determining cadmium is required. The advantages of flow injection analysis (FLA) such as small amounts of reagents and of the sample required, high rate of sample through-put and simplicity of instrumentation make it useful for the purpose. The reagent 2-(2-benzothiazolylazo)-4,5-dimethyl-phenol (BTDMP) has been reported as a sensitive and highly selective reagent for cadmium. BTDMP was synthesized and purified and dissolved in dimethylformamide (DMF). A stock solution of 1000 ppm Cd was also prepared and appropriately diluted for other standard solutions. In order to have a simple FIA set-up, reagents were combined into a one reservoir system containing BTDMP/DMF solution and a borate buffer. The effects of reagent concentration, buffers, tubing length, sample volume, flow rate, and interfering ions were studied. It was found that less than 0.1 ppm Zn, 0.007 ppm Ni, 0.3 ppm Cu, 0.1 ppm Co and 0.1 ppm Hg would not interfere with 3 ppm Cd. A calibration curve was constructed of standard cadmium solutions (0-10 ppm Cd). Resulting FIA peaks yielded a straight line up to 10 ppm. Stock solution of the reagent, BTDMP (0.00009 M) in aqueous DMF (40%) containing a borate buffer (PH = 9) can be stored for at least a week. A fresh solution of working reagent is recommended due to its stability. (Doyle-PTT)

TRACE ELEMENT DISTRIBUTION IN SURFI-CIAL SEDIMENTS OF THE NORTHERN TYRRHENIAN SEA: CONTRIBUTION TO HEAVY-METAL POLLUTION ASSESSMENT. Pisa Univ. (Italy). Dipt. di Scienze dell'Ambiente e del Territorio.

L. Leoni, F. Sartori, V. Damiani, O. Ferretti, and M. Viel.

Environmental Geology and Water Sciences EGWSEI, Vol. 17, No. 2, p 103-116, March/April 1991. 12 fig, 5 tab, 15 ref.

Descriptors: "Heavy metals, "Marine pollution, "Marine sediments, "Path of pollutants, "Trace elements, "Tyrrhenian Sea, "Water pollution sources, Barium, Bed load, Chromium, Cobalt, Copper, Lead, Nickel, Sediment contamination, Vanadium, Zinc.

The trace element distribution in bottom sediments of the northern Tyrrhenian Sea results from the influx of materials both from natural and anthropogenic sources. Over much of the basin, the surface Pb, Cu, Zn, and As contents appear considerably enriched relative to those below 15 cm; among these metals, Pb shows the highest and most wide-spread enrichment. Only in the case of some coarse-grained sediments close to the mouth of Cecina River it is possible to relate anomalouslyingh Zn contents to natural resources. In all other sampling stations, the enrichments of Pb, Cn, Zn, and As are ascribed to man's influence. The sediment distributions of Co, Cr, and Ni do not seem

#### **Group 5A—Identification Of Pollutants**

to be related to anthropogenic activities; rather they mirror influx of materials derived from sources of ophiolitic rock. The distribution of barium shows only two significant positive anoma-lies, and both are related to natural causes. Concentrations of vanadium are high in a zone close to an important smelting plant; these are thought to be of anthropogenic origin. The surplus of metal contamination introduced in the northern Tyrrhenian Sea from man's activities, although so far relatively small, in the long term could cause serious problems if effective measures to reduce pollutant releases are not adopted. (Author's abstract) W91-11444

DEFORESTATION AND LEACHING OF NITROGEN AS NITRATES INTO UNDERGROUND WATER IN INTERTROPICAL ZONES; THE EXAMPLE OF COTE DIVOIRE. Montpellier-2 Univ. (France). Lab. d'Hydrogeolo-

For primary bibliographic entry see Field 2F. W91-11446

MEASURING LOW RADON LEVELS IN

DRINKING WATER SUPPLIES.

Maine Univ., Orono. Dept. of Civil Engineering.

J. D. Lowry.

Journal of the American Water Works Association JAWWA5, Vol. 83, No. 4, p 149-153, April 1991. 3 fig. 1 tab, 11 ref. AWWA Research Foundation Project 529-89.

Descriptors: \*Drinking water, \*Laboratory methods. \*Radiochemical analysis. \*Radon. \*Water Descriptors: Drinking water, "Laboratory meun-ods, "Radiochemical analysis, "Radon, "Water analysis, Data acquisition, Liquid scintillation counting, Measuring instruments, Optimization, Radioactivity techniques, Standards, Water qual-

Because a relatively low maximum contaminant level (approximately 300 pCi/L) is expected to be set for radon in the near future, research was conducted with liquid scintillation counting (LSC) to determine whether this method of analysis could to determine whether this mendod of analysis could be used for low levels of radon. It was determined that significant improvement in the LSC analysis of Rn at low levels can be achieved through optimization of the protocol and counting parameters. The limited extraction of Rn into the counting fluor makes it important to maximize the water-to fluor ratio and minimize the air void in the countnuor ratio and minimize the air votal in the counting vial. This must be done in conjunction with an optimization of the counting parameters of the instrument. A water-to-fluor volume ratio of 17:5 was found to be optimum for the conditions used in this study. The often used ratios of 10:10 and 10:5 are not optimum for LSC analysis of Rn. 10:5 are not optimum for LSC analysis of Rn. Counting with an optimized window and an optimized water-to-fluor ratio gives a lowest quantifiable level of 150 pCi/L. For a 2-sigma total sampling, an analytical uncertainty of 15%, and a one half-life decay, a lowest quantifiable level of 90 pCi/L (actual) can be achieved. These values are for a 60-min counting period and duplicate analysis. Lower values can be achieved if the counting period is increased; however, the values cited are for cost-effective commercial analysis of large numbers of samples. (Doria-PTT) W91-11463

## LATEX AGGLUTINATION FOR THE DETECTION OF CAMPYLOBACTER SPECIES IN WATER.

WATEK.
Withington Univ. Hospital, Manchester (England).
E. M. Sutcliffe, D. M. Jones, and A. D. Pearson.
Letters in Applied Microbiology LAMIE7, Vol.
12, No. 3, p 72-74, March 1991. 1 fig, 2 tab, 5 ref.

Descriptors: \*Bacterial analysis, \*Campylobacter, \*Pollutant identification, \*Water analysis, Bacteria, Culturing techniques, Ducks, Laboratory methods, Microbiological studies, Temperature

The isolation of Campylobacter spp. from water samples is accomplished with conventional medial when appreciable numbers of organisms are present. A commercially available sensitized latex suspension could detect viable (100 organisms/mL) or heat-killed C. jejuni. C. coli, C. upsaliensis, and

Helicobacter pylori required at least 100,000 organisms/mL for agglutination, whereas with C. jejuni reactions were observed in suspensions of jejuni reactions were observed in suspensions of 100 organisms/ml. Boiling the bacterial suspensions of C. jejuni did not affect the latex agglutination of C. jejuni did not affect the viable counts. sions of C. jejum did not affect the latex agglutina-tion. Comparisons were made of the viable counts and the latex agglutination results obtained with three replicates of three microcosms. C. jejumi was recoverable by culture for up to 16 d from micro-cosms kept at 4 C but for less than half this time at higher temperatures. The latex test remained posi-tive throughout and showed no diminution after 6 tive throughout and showed no diminution after 6 months storage of the microcosms. Gram-stained films made after 18 d showed that the organisms were predominantly coccal in shape. Water samples from a small pond inhabited by ducks and moorhens regularly yielded cultures of C. coli and was never later-positive, nor were pure cultures of C. coli isolated from this source. Water from a lake C. coli isolated from this source. Water from a lake used for recreation and known to be fed by sewage-contaminated streams was usually both culture-positive and latex-positive. Cultures yielded a mixture of serotypes of C. jejuni with counts in the order of > 250 organisms/100 mL. Water samples taken from drinker lines from different sheds on 3 farms, yielded a small proportion of positive results. Prolonged culture of the latex-positive samples was unsuccessful. (Doria-PTT) W91-11465

MONITORING OF ORGANOCHLORINE COMPOUNDS IN FINNISH INLAND WATERS POLLUTED BY PULP AND PAPER EFFLUENTS USING THE MUSSEL INCUBATION METHOD.

Water and Environment District of Central Fin-land, Jyvaskyla (Finland).

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 397-402, 1991. 1 tab, 11 ref.

Descriptors: \*Bioassay, \*Chlorinated hydrocarbons, \*Finland, \*Freshwater mussels, \*Monitoring, \*Pollutant identification, \*Pulp and paper industry, \*Pulp wastes, Analytical methods, Biralytical of the compounds, Industrial Chlorinated aromatic compounds, Industrial wastes, Mining, Mussel incubation method, Polychlorinated biphenyls, Water quality control.

In the summer of 1988 a full-scale monitoring of chlorophydrocarbons, chlorophenols and aromatic chloroethers was carried out in the freshwater recipients of pulp and paper industry using the mussel incubation method, which has been developed and tested in Finland since 1984. The total number of incubation stations was 40. The results showed that the highest concentrations of chlorophenols originating from pulp bleaching processes were found in the vicinity of pulp mills with no biological wastewater treatment plant. Other chlorophenolic compounds (airborne or mainly originating from chloro-disinfection of water, combustion, wood preservation and sawmills) were detected in small amounts at almost all the sites tested. The highest concentrations were found in the recipients of old sawmills. PCB (polychlorinated biphenyi) was also detected in considerable concentrations in some recipients. Mussel incubation tests now constitute an important part of mon-itoring from environmental toxins in Finnish inland watercourses. The method is used in particular for monitoring recipients of the pulp and paper indus-try, but it is also suitable for the detection and try, but it is also suitable for the detection and monitoring of toxic pollutants from waste pits, sawmills, mining and metalworking industries and power stations, as well as for investigation and monitoring of the watercourse effects of agricultural pesticides. (See also W91-11467) (Mertz-PTT)

HIGH-PERFORMANCE LIQUID CHROMATO-HIGH-PERFORMANCE LIQUID CHROMATO-GRAPHIC STUDY ON OXIDATION PROD-UCTS OF LIGNIN AND HUMIC SUBSTANCES, Jyvaeskyle Univ. (Finland). Dept. of Chemistry. J. S. Knuutinen, and J. P. Mannila. Water Science and Technology WSTED4, Vol. 24, No. 3/4, p. 437-440, 1991. 1 fig. 5 ref.

Descriptors: \*Analytical methods, \*High performance liquid chromatography, \*Humic substances,

\*Lignin, \*Oxidation, \*Pollutant identification, \*Wastewater analysis, Degradation, Industrial wastes, Laboratory methods, Pulp and paper in-dustry, Pulp wastes, Water pollution sources.

A convenient method of preparing samples and characterizing the mixture of degradation products obtained from alkaline cupric oxide oxidation of water samples containing lignin and humic substances was developed. The method was applied to one unpolluted humic water sample and a total mill effluent of a kraft pulp mill. The fractions obtained by ultrafiltration were oxidized and the products contained on the products of degradation products have analyzed. (mixtures of degradation products) were analyzed by reverse-phase high-performance liquid chroma-tography. Acetonitrile-0.01 molar phosphate buffer (pH 2) was used as the cluent in a gradient system and ultraviolet (set at 280 nanometers) as the detec-tion system. Cupric oxide oxidation of a kraft pulp mill effluent produced many of the same com-pounds as were found in the unpolluted humic water. Differences in the chromatograms of the high molecular mass fractions of the samples studied can be used to characterize natural lignin and ubstances of various origins and to distinguish between natural humic matter and lignin compounds formed in the pulp industry. Because large amounts of vanillin were formed from kraft pulp mill effluent, is it suspected that chlorinated vanillins could be formed in cupric oxide oxidation of those effluents. If this proves true, the procedure might be useful of establishment of the transport of chlorolignin in waters downstream of the mill. (See also W91-11467) (Mertz-PTT) W91-11513

DIRECT SAMPLING ION TRAP MASS SPECTROMETRY FOR THE RAPID DETERMINATION OF VOLATILE ORGANICS IN ENVI-RONMENTAL MATRICES.

Oak Ridge National Lab., TN. Analytical Chemis-

M. V. Buchanan, and M. R. Guerin. Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-015358. Price codes: A02 in paper copy, A01 in microfiche. Report No. CONF-8907123-1, (1989). 10p, 5 fig.

Descriptors: \*Ion trap mass spectrometry, \*Pollutant identification, \*Volatile organic compounds, \*Laboratory methods, Chemical analysis, Data acquisition, Measuring instruments, Mass spectrometry, Chlorinated aromatic compounds, Performance evaluation. Solvents.

Analytical methods are currently being developed for the rapid determination of part-per-billion (ppb) or lower levels of volatile organics (VOCs) in water, soil, air, and oil samples using direct in water, soil, air, and oil samples using direct sampling in combination with a rf quadrupole ion trap mass spectrometer (ITMS). Features of the ITMS which are important to the success of these applications include the ability to perform selective chemical ionization, high efficiency collision inchemical ionization, high efficiency collision in-duced dissociation (MS/MS) experiments, and excellent instrument reliability and tolerance to rela-tively high operating pressures. Excellent detec-tion limits, linearity of response, and reproducibil-ity have been demonstrated for the determination of volatiles in water, soil, and air. Because no chromatography is used, sample turn-around is typically < 5 minutes. Direct sampling is accomplished with a split-on-split capillary restrictor plished with a split-on-split capillary restrictor interface which has been designed to accept a wide variety of sampling devices. Volatiles in water can be determined without any sample preparation simply by direct purge and helium into the mass spectrometer sample interface. A helium flow rate of approximately 100 mL/min through a sparging device enables reproducible purging of volatiles from a 15 mL water sample in < 3 minutes. Soil samples are prepared by adding 15 mL of distilled water to 5 em of soil to form a shurry. Chlorinated water to 5 gm of soil to form a slurry. Chlorinated solvents have been successfully purged from samples of used motor oil without any sample prepara-tion. VOCs in air may be determined either by direct sampling or by preconcentration on a resin trap followed by direct thermal desorption into the ITMS. Direct air sampling has an estimated detec-tion limit of approximately 1 ppb, while precon-

Sources Of Pollution-Group 5B

centration is effective for ppt or lower levels of constituents. (Author's abstract) W91-11555

STATUS REPORT ON REMEDIAL INVESTI-GATION OF THE 300 AREA PROCESS PONDS. Battelle Pacific Northwest Labs., Richland, WA. For primary bibliographic entry see Field 5G. W91-11583

#### 5B. Sources Of Pollution

UNCERTAINTY ANALYSIS FOR A LINEAR PROGRAMMING MODEL FOR ACID RAIN

PROGRAMMING MODEL FOR ACID I ABATEMENT. Meteorologischer Dienst der DDR, Potsdam. For primary bibliographic entry see Field 7C. W91-10470

INCREASED PRECIPITATION ACIDITY IN THE CENTRAL SIERRA NEVADA. California Univ., Davis. Div. of Environmental

E. R. Byron, R. P. Axler, and C. R. Goldman. Atmospheric Environment ATENBP, Vol. 25A, No. 2, p 271-275, 1991. 2 fig, 33 ref.

Descriptors: \*Acid rain, \*Chemistry of precipita-tion, \*Nitrates, \*Precipitation, \*Water pollution sources, Acidity, Alpine regions, California, Chem-ical properties, Hydrogen ion concentration, Lake Tahoe, Sierra Nevada, Sulfates.

Bulk precipitation has been collected continuously for chemical analysis on a storm event basis since 1979 at the Ward Valley Bench Station at Lake Tahoe, California. The station is 300 m higher than Tahoe, California. The station is 300 m higher than the lake, 6.8 km from the shore, and is only 3 km east of the Sierra Nevada divide. The 4 m high tower holding the sampler is in an extensive subalpine meadow surrounded by pine/fir forests; the closest development is low density housing 1 km to the northeast. Between 1979 and 1986, precipitation profile in progression in the profile of the specific profile in the specific profile. the northeast. Between 1979 and 1986, precipita-tion acidity increased significantly on the crest of the central Sierra Nevada. Variation in precipita-tion pH was closely associated with change in intrate concentrations but not with sulfate. This area of the Sierra Nevada crest contains many acid-sensitive, poorly buffered lakes and ponds that can be adversely affected by increasing precipita-tion acidity. (Mertz-PTT) W91-10471

IMPACT OF CHANGING REGIONAL EMIS-SIONS ON PRECIPITATION CHEMISTRY IN THE EASTERN UNITED STATES.

New York Botanical Garden, Bronx, NY. Inst. of Ecosystem Studies. For primary bibliographic entry see Field 5G. W91-10473

STATISTICAL ANALYSIS OF ERRORS IN ES-SIAIISIICAL ANALYSIS OF ERRORS IN ES-TIMATING WET DEPOSITION USING FIVE SURFACE ESTIMATION ALGORITHMS. Pennsylvania State Univ., University Park. Envi-ronmental Resources Research Inst. For primary bibliographic entry see Field 7B. W91-10474

RELATIONSHIP BETWEEN MEAN AND STANDARD DEVIATION IN PRECIPITATION CHEMISTRY MEASUREMENTS ACROSS EASTERN NORTH AMERICA.

Atmospheric Environment Service, Downsview For primary bibliographic entry see Field 2B. W91-10475

DRY DEPOSITION WASHOFF FROM FOREST TREE LEAVES BY EXPERIMENTAL ACID RAINFALL.

RAINFALL.
Emory Univ., Atlanta, GA. Dept. of Biology.
C. S. Potter, and H. L. Ragsdale.
Atmospheric Environment ATENBP, Vol. 25A,
No. 2, p 341-349, 1991. 6 fig, 2 tab, 36 ref. USDA

Forest Service Grant No. 29-034 and National Science Foundation-LTER Grant No. BSR

Descriptors: "Acid rain, "Acid rain effects, "Dry deposition, "Leaves, "Path of pollutants, "Precipitation, "Throughfall, Canopy, Deciduous trees, Hydrogen ion concentration, Potassium, Sulfates, Washoff curve analysis.

Freshly collected leaves from a regenerating forest stand were treated with experimental acid rainfall of pH 4.6 in short-duration laboratory washing trials. The dynamics of initial sulfate and potassium trials. The dynamics of initial sulfate and potassium washoff from leaf surfaces were similar between elements and among species. Sulfate and potassium followed negative exponential foliar element washoff curves. Potassium leaching from foliage may occur with dry deposition washoff. The time for completion of the initial element washoff from leaves, in the range of 6-8 minutes, was similar to previously reported leaf immersion washing times. Potassium was washed from leaf surfaces at a faster rate than was sulfate. Tree species were Potassium was washed from leaf surfaces at a faster rate than was sulfate. Tree species were generally similar for dry deposition washoff amounts and rates within leaching trials. Washoff from lower leaf surfaces was negligible. The washoff curve analysis appeared to produce an accurate estimate of previous dry deposition to leaf surfaces, and eliminated many of the problems and limitations associated with bulk leaf washing impression approached. Authors bettered. mersion approaches. (Author's abstract) W91-10476

INTERANNUAL VARIABILITY IN ACIDIC DEPOSITION ON THE MT. MITCHELL AREA

DEPOSITION ON THE MIT. MITCHELL AREA FOREST.
North Carolina State Univ. at Raleigh. Dept. of Marine, Earth and Atmospheric Sciences.
N. H. Lin, and V. K. Saxena.
Atmospheric Environment ATENBP, Vol. 25A, No. 2, p 517-524, 1991. 3 fig, 5 tab, 38 ref. EPA Agreement No. ESRL-CA-01 and contracts CRS 812444-01-0, 812444-02-0, and 812444-03-0.

Descriptors: \*Acid rain effects, \*Deposition, \*Forests, Canopy, Chemistry of precipitation, Cloud chemistry, Dry deposition, Mount Mitchell, Mountains, Nitrogen oxides, North Carolina, Ozone, Precipitation, Sulfur dioxide.

It has been suggested that forest decline at high elevation mountains in the eastern U.S. is associated with the deposition of acidic substances on the forest canopy through dry, wet and cloud deposition pathways. To determine the relative importance of these deposition mechanisms, a field study was initiated in May 1986, at Mount Mitchell, N.C. Since Mount Mitchell is frequently immersed in clouds (immersion time being in the range of 29-41%), the investigations were primarily focused on the collection of cloud water and the monitoring of meteorology and ambient air quality. The precipioners of the collection of cloud water and the monitoring of meteorology and ambient air quality. The precipioners are made to the collection of cloud water and the monitoring of meteorology and ambient air quality. The precipioners 41%), the investigations were primarily focused on the collection of cloud water and the monitoring of meteorology and ambient air quality. The precipitation data and related chemistry were obtained from a nearby NADP (National Atmospheric Deposition Program) site (Clingman's Peak). To estimate the dry and cloud deposition, the deposition relocities for gases and the rates of cloud deposition for cloud droplets were calculated with the ATDD (Atmospheric Turbulence and Diffusion Division, National Oceanic and Atmospheric Administration) model and a cloud deposition model. The wet deposition was obtained from NADP annual reports. Computations showed the deposition velocities for SO2, NO2, and O3 to be in the range of tenths of crn/second. The mean rate of cloud deposition was about 0.13-0.21 mm/hour. The rainfall ranged from 40 to 609 cm during the growing seasons (from mid-May to the end of September) of 1986-1988. Using these deposition fluxes of sulfur compounds were primarily contributed through the cloud capture mechanism (60%) followed by incident precipitation (25%) and dry deposition (15%). As to, the deposition (1980). followed by incident precipitation (25%) and dry deposition (15%). As to the deposition fluxes of deposition (15%). As to the deposition fluxes of nitrogen compounds, cloud deposition contributed about 50%, wet deposition about 25% and dry deposition about 25%. A comparison of deposition estimates at Mount Mitchell with those at other sites showed that the sulfate deposition at sites exceeding 1200 m above sea level in elevation in Bavaria, Germany and the eastern U.S. was almost identical within error limits. (Author's abstract)

W91-10478

MATHEMATICAL SIMULATION OF POLLUT-ANT DISPERSION.

Instituto Nacional de Ciencia y Tecnica Hidricas, Buenos Aires (Argentina).
P. E. Carreras, and A. N. Menendez.

Ecological Modelling ECMODT, Vol. 52, No. 1/2, p 29-40, November 1990. 9 fig. 7 ref.

Descriptors: \*Computer models, \*Model studies, \*Municipal wastewater, \*Path of pollutants, \*Wastewater pollution, Argentina, Buenos Aires, Plysures, Simulation, Water currents, Water pollution sources. Wind.

A numerical technique based on the computation of contaminant dispersion in a localized area is examined. It allows a two-dimensional description of the plume when the dispersion scale is much smaller than the hydrodynamic one. The technique was implemented in the computational system MANCHAS, developed at the Laboratorio de Hidraulica Aplicada, and was applied to the plume generated by the sewage discharge of Buenos Aires city in the Rio de la Plata. The velocity and depth fields were achieved by the computational system HIDROBID II, also developed at the Laboratorio de Hidraulica Aplicada. The physical parameters involved in the phenomenon, such as dispersion coefficients and time of decay, were estimated from field measurements. Some numerical tests were performed for different tides and catmated from field measurements. Some humeri-cal tests were performed for different tides and wind velocities. It can be concluded from the results that the wind, as a generator of drift cur-rents, is the relevant mechanism of transport of the pollutant. (Author's abstract) W91-10488

OIL SPILLS IN MANGROVES: A CONCEPTU-AL MODEL BASED ON LONG-TERM FIELD OBSERVATIONS.

Sao Paulo Univ. (Brazil). Inst. de Biociencias C. M. Jacobi, and Y. Schaeffer-Novelli. Ecological Modelling ECMODT, Vol. 52, No. 1/ 2, p 53-59, November 1990. 1 fig, 11 ref.

Descriptors: \*Fate of pollutants, \*Mangrove swamps, \*Model studies, \*Oil spills, Coasts, Computer models, Oil pollution, Sediment contamination, Tidal effects, Tidal flats, Wetlands.

A conceptual model was proposed for evaluating the residence time of oil in mangrove environments. It assumed that, after oil had spread over a mangrove coastline, it remained in the environment by retention in the sediment. Removal was mainly in association with seaward particle export. Since detritus export depends on tidal flush, the area affected by an oil spill could be divided into sections parallel to the coastline having different removal rates increasing seaward (under little river flush and regular topography). The division of the total spilled area into segments allowed more complicated topography than a regular mild slope to be examined. In these cases, removal would still depend on tidal flush but not as a direct function of tidal amplitude. The model has to be improved with data on the concentration of oil in the field over time, for better estimations of removal rates over time, for better estimations of removal rates and related factors, and with calibration of detritus export in each segment, since these affect removal rates. Usually, in energetic models, only a general export rate is considered. (Mertz-PTT) W91-10489

COMPARISON OF NOCTURNAL DRAINAGE FLOW IN THREE TRIBUTARIES.

Argonne National Lab., IL. Environmental Research Div. For primary bibliographic entry see Field 2E. W91-10501

NEW DEAD SEA.

For primary bibliographic entry see Field 5C. W91-10504

#### Group 5B-Sources Of Pollution

METEOROLOGY AND OCEANOGRAPHY IN THE SETO INLAND SEA.
Kobe Marine Observatory (Japan).
For primary bibliographic entry see Field 2L.
W91-10520

RUNOFF CHARACTERISTICS OF COD, BOD, C, N, AND P LOADINGS FROM RIVERS TO

C, N, AND P LOADINGS FROM RIVERS 10 ENCLOSED COASTAL SEAS.
National Inst. for Environmental Studies, Tsukuba (Japan). Water and Soil Environment Div.
T. Inoue, and S. Ebise.
Marine Pollution Bulletin MPNBAZ, Vol. 23, p 11-14, 1991. 4 fig, 5 tab, 5 ref.

Descriptors: \*Biological oxygen demand, \*Chemical oxygen demand, \*Eutrophication, \*Japan, \*Marine pollution, \*Nitrogen, \*Nutrient concentrations, \*Organic carbon, \*Path of pollutants, \*Phosphorus, \*Stream discharge, \*Water pollution sources, Alkalinity, Coastal areas, Nutrient transport, Runoff, Sediment chemistry, Seto Inland Sea, Water quality standards. Descriptors: \*Biological oxygen demand, \*Chemical oxygen demand, \*Eutrophication, \*Japan, \*Marine pollution, \*Nitrogen, \*Nutrient concen-

The three elements carbon (C), nitrogen (N), and phosphorus (P), are very important in eutrophication in enclosed coastal areas. The primary source of C, N, and P is inflow from rivers, rather than release from sediment in the closed sea. In Japan, the environmental quality standards for organic pollution in rivers and seas are different. In a river, pollution in rivers and seas are different. In a river, organic pollution determination is based on BOD; in seas, organic pollution determination is based on alkaline COD. These different standards lead to difficulties in obtaining consistent water quality management of the water system from rivers to enclosed coastal seas. Hinuma River showed runoff loading of alkaline COD, BOD, C, N, and P in weekly observations in 1988 and 1989. When flow rate increases, increasing ratios are seen first in phosphorus, followed by carbon, then nitrogen. in phosphorus, followed by carbon, then nitrogen. Eighty-eight percent of the phosphorus runs off as particulate phosphorus; 84% of nitrogen runs off as dissolved nitrogen. Nitrogen runs off at an almost constant concentration, while most phosphorus runs off in high flow stages. The particulate phosphorus behavior after inflow to the enclosed coastal sea is an important factor in eutrophication. (Author's abstract)
W91-10521

#### POLLUTION AND PROTECTION OF BOHAI BAY.

Academia Sinica, Beijing (China). Research Center for Eco-Environmental Sciences.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 15-18, 1991. 2 fig, 3 ref.

Descriptors: \*Bohai Bay, \*China, \*Coastal waters, \*Flow discharge, \*Marine pollution, \*Path of pollutants, \*Wastewater pollution, \*Water pollution control, \*Water quality, Eutrophication, Inorganic nitrogen, Inorganic phosphorus, Mortality, Nutrient concentrations, Organic matter, Storm runoff.

Bohai Bay is one of the primary semi-enclosed coastal seas in China, situated in the west Bohai Sea and coast of Tianjin city, in the Hebong and Shandong provinces. With an area of 16,000 sq km, Beijing-Tianjin rivers polluted with effluent and storm runoff. Water quality surveys showed high levels of oil and trace metals, as well as elevated organic matter concentrations. These results indiorganic marter concentrations. These results mur-cated that despite Bohai Bay's assimilation and dilution capacity for pollutants, the pollution had led to higher levels of eutrophication, and fish and shellfish mortality. For the future, measures must be taken to reduce the amount of inorganic nitro-gen, inorganic phosphorus and organic pollutants discharged into the bay. (Brunone-PTT) W91-10522

# EVALUATION OF PRIMARY PRODUCTION LOADS AND THEIR CONTROL IN ENCLOSED SEAS.

Yamaguchi Univ. (Japan). Dept. of Civil Engineer-

For primary bibliographic entry see Field 5G.

W91-10524

OUTFLOW AND THREE-DIMENSIONAL SPREADING OF RIVER WATER IN EN-

Osaka Univ. (Japan). Dept. of Civil Engineering. For primary bibliographic entry see Field 2L. W91-10525

CIRCULATION AND POLLUTANT DISPERSION IN MASAN-JINHAE BAY OF KOREA.
Korea Ocean Research and Development Inst., Seoul (Republic of Korea).

S. W. Kang.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p
37-40, 1991. 5 fig, 1 tab, 6 ref.

Descriptors: \*Dispersion, \*Hydrologic models, \*Korea, \*Marine pollution, \*Masan-Jinhae Bay, \*Model studies, \*Path of pollutants, \*Water circulation, Chemical oxygen demand, Salinity, Stagnant water, Tidal currents, Water currents, Water temperature.

Circulation and dispersion of pollutants in the Masan-Jinhae Bay, Korea (one of the most polluted water bodies in Korea) were studied through numerical experiments and hydrographic field surveys. The field survey includes the measurements of water level, currents, temperature, salinity and chemical oxygen demands (COD). To simulate the circulation and dispersion of pollutants discharged into the bay, a two-dimensional finite element scheme was employed. The calculated tidal cur-rents were consistent with the current meter measurements. Using the circulation model, dispersion of pollutants was estimated, resulting in very slow mixing with the open waters due to near-stagnancy of the inner bay waters. (Author's abstract) W91-10526

# NUMERICAL SIMULATION OF WATER QUALITY IN TOKYO BAY.

Japan NUS Co. Ltd., Osaka. N. Hamano, and Y. Nakagawa Marine Pollution Bulletin MPNBAZ, Vol. 23, p 45-49, 1991. 5 fig, 1 tab, 4 ref.

Descriptors: \*Japan, \*Marine pollution, \*Mathematical models, \*Model studies, \*Primary productivity, \*Tokyo Bay, \*Water quality, Limiting nutrients, Monitoring, Nitrogen, Nutrient concentrations, Organic loading, Particulates, Phosphorus, Water quality monitoring, Water quality standards.

The JATWEM model was developed to satisfy the need for a model that can be applied to all kinds of water bodies, and is easy to understand and use in water oddies, and is easy to understand and use in the evaluation of primary production. The model consists of an equation for total nitrogen and phos-phorus in a soluble state or as small particulates which act like water, and an equation for large particulates. The JATWEM model enables water quality to be calculated by an inductive parameter method based mainly on information obtained by field observation. Primary production is estimated from simulated values of total nitrogen and phosphorus. A calculation made for Tokyo Bay accurately predicted the water quality of the bay, alrately predicted the water quality of the bay, air though the calculated chemical oxygen demand value significantly exceeded the observed value, even though the concentration of nutrients were consistent with observed values. These results indi-cate that the model cannot evaluate consistently the actual primary production near inflow load areas when considering only nitrogen and phos-phorus as limiting factors. (Brunone-PTT) W91-10528

5-YEAR SCIENTIFIC RESEARCH PRO-GRAMME FOR MANAGING COASTAL SEAS, Proudman Oceanographic Lab., Birkenhead (Eng-

For primary bibliographic entry see Field 2L. W91-10531

INVESTIGATION ON TURBIDITY AND FLOW PATTERNS IN HALF-CLOSED SEA AREA,

Chemical Inst. for Industry, Tsukuba (Japan). K. Abe, Y. Inomata, and S. Ogata. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 69-73, 1991. 4 fig. 1 tab, 4 ref.

Descriptors: \*Coastal waters, \*Data interpretation, \*Ocean circulation, \*Path of pollutants, \*Remote sensing, \*Turbidity, Industrial development, Japan, Korea, Satellite technology, Sea of Japan, Seto

The Seto Inland Sea is the largest enclosed coastal area in Japan. It is bordered by an active industrial district, with many factories. The marine features of enclosed bays and coastal seas were investigated by satellite remote sensing. Turbidity in the Kanmon area and in Hiroshima Bay was estimated by using a new classification technique and verified with 'sea truth' data. Existing classification techniques for extracting information from satellite image data are almost all based on pixel-by-pixel processing; hence, data-processing time is very long. A new classification method, called the histogram overlay method (HOM), was developed. The HOM uses 'fuzzy likelihood' based on cell units comprised of several to hundreds of pixels. The performance of this method on a personal computer was compared with that for the most probable number (MPN) method. The new method was more stable given the noise and fluctuations of system parameters, in addition to requiring less computing time than the MPN method, and the computing time than the MFN method, and the results were almost the same as those from the MPN method. This technique was extended and applied to environmental researches on industrialized coastal areas of southern Korea which border the Sea of Japan. (Brunone-PTT) W91-10532

## FLUIDIZATION OF MARINE MUD BY

California Univ., Berkeley. Dept. of Civil Engi-

neering. H. T. Chou, J. R. Hunt, and M. A. Foda. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 75-81, 1991. 4 fig, 3 ref.

Descriptors: \*Marine sediments, \*Mud, \*Path of pollutants, \*Sediment transport, \*Suspended sediments, \*Wave effects, Fluid friction, Organic hydrocarbons, Polychlorinated biphenyls, Sediment-water interfaces,

Transport of soft marine mud is of concern because many water pollutants, such as trace metals, petro-leum hydrocarbons, PCBs and pesticides, are pre-dominantly associated with the surfaces of cohe-sive mud deposits. The structure of cohesive sediments is controlled by the input energy. At low oscillatory strains, cohesive sediment structure is described as an elastic solid. At higher oscillatory described as an elastic solid. At higher oscillatory strains, the sediment structure is viscoelastic, and at very high strain amplitudes, the sediment behaves as a viscous fluid. Rheological measurements of cohesive sediments provide a quantitative evaluation of these viscoelastic properties as functions of clay mineralogy, ionic strength of solutions, concentrations of solids, and oscillatory frequency. This viscoelastic representation of sediment structure can be used to predict the responses of such ture can be used to predict the responses of such sediments to oscillatory shear. (Author's abstract)

# WATER QUALITY ASSESSMENT AND PRO-TECTION MEASURES OF A SEMI-ENCLOSED COASTAL AREA: THE BAY OF THERMAIKOS (NE MEDITERRANEAN SEA).

Thessaloniki Univ., Salonika (Greece). Lab. of Hydraulics and Hydraulic Works. For primary bibliographic entry see Field 5G. W91-10534

# STATUS OF EUTROPHICATION IN THE GREAT BARRIER REEF LAGOON.

Queensland Univ., Brisbane (Australia). Dept. of Chemical Engineering.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p

#### Sources Of Pollution—Group 5B

89-93, 1991. 6 fig, 15 ref.

Descriptors: \*Australia, \*Eutrophication, \*Great Barrier Reef, \*Lagoons, \*Marine pollution, \*Path of pollutants, Cyanophyta, Nutrient concentrations, Phytoplankton, Runoff, Stream discharge.

Historical data on the levels of nutrients and phytoplankton in the Great Barrier Reef (GBR) lagoon indicates that background levels of phosphate-phosphorus and phytoplankton have increased significantly over the past 50 to 60 years and that the levels appear to be at or above the eutrophication threshold level for coral reef waters. Other data indicate that river discharge probably has a major impact on the nutrient status of the GBR lagoon, but other factors such as the nitrogen-fixing blue-green alga, Trichodesmium, so the could also be important. Trichodesmium has the ability to introduce large amounts of new nitrogen to the ecosystem, and phosphorus levels could be driving its growth. To date, little effort has been made to assess the impact of eutrophication on the toral reef communities. Because the background nutrient levels are relatively high, both runoff and sewage discharges could have serious impacts on nearby coral reef communities. Tertiary treatment, such as nutrient removal, of sewage should be required for all discharges in the vicinity of coral reefs and special precautions need to be exercised when designing runoff drainage systems. (Author's abstract)

EUTROPHICATION IN HIROSHIMA BAY. Hiroshima Prefectural Research Center for Environmental Science (Japan).

T. Seiki, E. Date, and H. Izawa.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p
95-99, 1991. 5 fig, 4 tab, 9 ref.

Descriptors: "Cycling nutrients, "Eutrophication, "Hiroshima Bay, "Japan, "Marine pollution, "Path of pollutants, "Water pollution sources, Nitrogen, Nutrient concentrations, Phosphorus, Phytoplankton, Primary productivity, Sediment chemistry, Seto Inland Sea, Suspended sediments, Water circulation

The Seto Inland Sea is bounded by Honshuu, Shikoku and Kyuushuu and has had increased levels of water pollution since the industrialization and urbanization began around 1965. Eutrophication in northern Hiroshima Bay, Japan, was investigated to provide information on nutrient budgets in aquatic circulation processes, i.e. primary production, settling flux of particulate organic matter (POM) and benthic remineralization. Primary production contributed to the organic pollution in the northern bay more than land-based organic loadings by a factor of ten. Approximately 60 to 70% of the POM originating in phytoplankton was easily remineralized into inorganic nutrients during the settling process in water. About 60% of the introgen and 70% of the phosphorus in benthic sediments could be returned to the water column. (Author's abstract)

HEAVY METAL POLLUTION IN SEDIMENT FROM THE SETO INLAND SEA, JAPAN.

Government Industrial Research Inst., Chugoku, Kure (Japan). A. Hoshika, T. Shiozawa, K. Kawana, and T.

A. Hoshika, T. Shiozawa, K. Kawana, and T. Tanimoto.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p

101-105, 1991. 4 fig. 4 ref.

Descriptors: "Heavy metals, "Japan, "Marine pollution, "Path of pollutants, "Sediment contamination, "Seto Inland Sea, Coastal waters, Copper, Geochemistry, Model studies, Sediment chemistry,

tion, \*Seto Inland Sea, Coastal waters, Copper Geochemistry, Model studies, Sediment chemistry Zinc.

To evaluate the geochemical and environmenta behavior of heavy metals in the Seto Inland Sea

To evaluate the geochemical and environmental behavior of heavy metals in the Seto Inland Sea, the largest semi-enclosed coastal sea in Japan, distributions of heavy-metal pollutants were examined and mass balances of zinc and copper were studied by applying a simple box model. According to core samples, increases in the heavy-metal content

of sediments had already started by the late 1800's and are thought to have been due to human activities. Recently, sediment pollution in Osaka Bay (which is the most contaminated area in the Sea) has tended to decrease. In 1980, total sediment loads of copper and zinc over the whole area of the Sea were estimated to be 630 and 3500 tons per year, respectively. Furthermore, the sediment loads due to human and non-human activities were estimated separately to be 310 and 320 tons per year for copper, and 1700 and 1800 tons per year for zinc. Total inputs of copper and zinc into the Sea were estimated to be 870 and 4250 tons per year, with about one-half being the results of human activities. Seventy percent of the copper input and 80% of the zinc input are accumulated in the sediments. (Author's abstract)

SCAVENGING PROCESSES OF MARINE PAR-TICLES IN OSAKA BAY. Kagawa Univ., Miki (Japan). Faculty of Agricul-

ture. S. Montani, Y. Mishima, and T. Okaichi. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 107-111, 1991. 3 fig, 4 tab, 8 ref.

Descriptors: \*Biotransformation, \*Fate of pollutants, \*Marine sediments, \*Nutrient transport, \*Osaka Bay, \*Particulate matter, \*Path of pollutants, \*Pollutant scavenging, Cycling nutrients, Japan, Nitrogen, Sedimentation, Tidal effects.

The fate of pollutants introduced into Osaka Bay by human activities was investigated using integrated studies of scavenging mechanisms and biotransformation processes. Scavenging by marine particles was studied using nutrient (C, N, P) distribution as an indicator. Nutrient concentrations in the water and on suspended particles, on settling particles, and in surface sediments were monitored for three years (1985 to 1987). Large variations were found which appeared to depend on environmental conditions. Nutrient concentrations on suspended and settling particles decreased from the inner part of the bay to the offshore area. The position of the tidal front in Osaka Bay agreed very closely with the 20 to 30 m depth; the chemical character of suspended and settling particles was considerably different outside vs. inside the tidal frontal area. At the offshore station, settling particles were mainly 'old particles' in which the labile organic matter fraction was already decomposed. Sedimentation of nitrogen in the inner part of the bay accounted for approximately 6% of all nitrogen inputs to Osaka Bay. Thus, marine particles are very important in nutrient scavenging and cycling in Osaka Bay. (Author's abstract)

PRESENT STATE OF ENVIRONMENTAL POLLUTION IN COASTAL SEA AREA AND MEASURES FOR PROTECTION.

Institutul Roman de Cercetari Marine, Constanta (Romania).

(Romania). P. E. Mihnea, E. Cuingioglu, and I. Pechneanu. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 117-121, 1991. 5 fig, 5 tab, 12 ref.

Descriptors: \*Black Sea, \*Coastal areas, \*Eutrophication, \*Nutrient concentrations, \*Path of pollutants, \*Water pollution control, Biological wastewater treatment, Chlorophyll a, Heavy metals, Outfall, Phytoplankton, Toxicity, Wastewater treatment.

The eutrophication process in the Black Sea has accelerated for twenty years, since urbanization and industrial development has begun. Extensive and increased nutrient input into the Black Sea over the last two decades has led to elevated nutrient concentrations. The highest levels were found in front of outfalls or in shallow areas. A comprehensive scientific survey, with about thirty parameters, over a time period of 1979 up to 1989 has been developed, as well as experimental work to test the influence of the main polluting compounds on the marine organisms. Phytoplankton communities developed high population densities, with high levels of chrysophytes and cryptophytes. Large standing crops led to high concentrations of

chlorophyll a. The final outcome was suboxic, marine organism mortality and decreases in the number of landed fish. Ecotoxicological tests must include all the parent chemical compounds or breakdown products that may affect the natural environment. Improvements to the water quality could be made by filtration and irrigation to remove residual biological solids from effluent, advanced treatment of sewage and industrial wastes to remove almost all the phosphorus by precipitation; and development of new treatment technology to remove nitrogen compounds and heavy metals. (Brunone-PTT)

EFFECT OF A SPRING PHYTOPLANKTON BLOOM ON DISSOLVED COPPER SPECIATION IN BEDFORD BASIN.

Dalhousie Univ., Halifax (Nova Scotia). Dept. of Oceanography.
D. E. Slauenwhite, P. J. Wangersky, and B. D.

D. E. Slauenwhite, P. J. Wangersky, and B. D. Johnson.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 137-144, 1991. 4 fig, 24 ref.

Descriptors: \*Algal blooms, \*Bedford Basin, \*Copper, \*Decontamination, \*Nova Scotia, \*Path of pollutants, \*Phytoplankton, \*Trace metals, Algal growth, Coastal waters, Primary productivity, Stream discharge, Toxicity.

Phytoplankton during a bloom have been hypothesized to decrease the concentration of toxic free copper ions by releasing organic chelates that coordinate the copper and thereby detoxify the water. The concentration and speciation of dissolved copper was measured in Bedford Basin, Nova Scotia during the spring phytoplankton bloom of 1987 using in situ extraction techniques. The results indicated little change in the concentration of copper bound by organic chelators extractable by reverse phase techniques during the growth period of the bloom. The concentration of total dissolved copper and organic bound copper in this system was controlled by local fresh water inputs. The total concentration of copper was found to vary from 5 nM to 10.5 nM, concentrations typical of coastal waters. Primary productivity has a secondary impact. (Brunone-PTT)

LIFE CYCLE STRATEGIES OF THE RED TIDE CAUSING FLAGELLATES CHATTONELLA (RAPHIDOPHYCEAE) IN THE SETO INLAND SFA

Nansei Regional Fisheries Research Lab., Hiroshima (Japan).
C. Imai, S. Itakura, and K. Itoh.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 165-170, 1991. 6 fig, 19 ref.

Descriptors: \*Algal blooms, \*Biological pollution, \*Coastal waters, \*Flagellates, \*Japan, \*Life history studies, \*Path of pollutants, \*Red tide, \*Seto Inland Sea, \*Water pollution effects, Algal growth, Dormancy, Fish farming, Life cycles, Mortality, Seasonal distribution, Sediments.

Chattonella antiqua and Chattonella marina are the most noxious red tide flagellates, causing serious damage to fish farms, especially yellowtail fisheries, in Japanese coastal waters such as the Seto Inland Sea (SIS) during the summer. Cysts of Chattonella were identified from sediments of the SIS. These cysts overwinter on the sea bottom and play an important role in initiating summer red tides. Most of the cysts adhere to solid surfaces such as diatom frustules and sand grains, which may aid in keeping the cyst populations within seed beds for the red tides. Temperature is a principal factor affecting the physiology of cysts of Chattonella. No cysts germinate at 10 C. Optimum temperature range is between 20 C and 25 C for germination. For maturation (acquisition of germination) of the cysts, low storage temperature of 11 C or below for more than four months is essential, whereas no significant maturation is observed at 20 C or more. In freshly collected sediments, marked seasonality of germination was confirmed in Suo-Nada. The cysts spend a period of spontaneous

#### **Group 5B—Sources Of Pollution**

dormancy between autumn and the next spring, and they mature during the winter season. The life cycle of Chattonella is therefore well-adapted to the seasonal temperature fluctuation in the SIS. Furthermore, alternation between the benthic and planktonic stage is unconstrained by the shallow-ness of the SIS. The life cycle of Chattonella can be regarded as a superior life history strategy for the occurrences of red tides in temperate waters like the SIS. (Author's abstract) W91-10546

LONG TERM ECOLOGICAL CHANGES IN THE GULF OF THAILAND.
Department of Fisheries, Bangkok (Thailand). Marine Fisheries Div.

S. Suvapepun.
Marine Pollution Bulletin MPNBAZ, Vol. 23, p 213-217, 1991. 6 fig, 2 tab, 9 ref.

Descriptors: \*Algal blooms, \*Coastal areas, \*Ecosystems, \*Environmental effects, \*Gulf of Thailand, \*Marine pollution, \*Path of pollutants, \*South China Sea, \*Water pollution effects, Biomass, Estuaries, Fisheries, Mangrove trees, Molbate, Nutritiest Nutrient concentrations, Organic loading, lusks. Population density, Species diversity

The Gulf of Thailand is a tropical enclosed sea in the southwestern part of the South China Sea. The the southwestern part of the south China Sea. I ne increasingly deteriorated conditions in the coastal environment have raised concerns among scientists and the public. The frequency of algal blooms has markedly increased in some estuarine and mangrove areas corresponding to the increase in nutrient loading. Patterns of change in the biomass of phytoplankton are linked to the increased nutrient. discharge in the Inner Gulf. The changes in species composition of demersal fishes and benthic communities, and large decreases in population sizes or even disappearance of species have also been noted in this area. Bivalve fisheries had deteriorated as in this area. Bivalve fisheries had deteriorated as early as 1970, due to the organic pollution discharged directly in the form of river outflow to the sea. The decline of fisheries in the Gulf of Thailand is primarily caused by overfishing; however, discharges of organic pollutants from cities and industries have caused marine pollution in some estuarine and coastal areas and have impacted the coastal aquaculture activities and bivalve fishery. (Author's abstract) thor's abstract) W91-10551

EFFECTS OF OIL POLLUTION ON BIO-ECOLOGY AND FISHERIES ON CERTAIN ENCLOSED COASTAL REGIONS OF ARABI-AN SEA.

Marine Products Export Development Authority, Cochin (India). V. D. Ramamurthy. Marine Pollution Bulletin MPNBAZ, Vol. 23, p

239-245, 1991, 10 ref.

Descriptors: \*Arabian Sea, \*Coasts, \*India, \*Marine pollution, \*Oil pollution, \*Oil spills, \*Water pollution offects, \*Water pollution sources, Bioaccumulation, Coastlines, Fish larvae, Inlets, Juvenile growth stage, Mortality, Organic hydro-

The long coastline of the Arabian Sea along the west coast of India has numerous enclosed areas and inlets where threats of crude oil pollution have increased in severity for the last few years. The oil pollution generally originates from harbors and marine terminals, offshore oil wells, oil tanker dis-asters, and land sources. The enclosed regions of inlets are heavily exposed to crude oil pollution caused by tankers carrying oil from the Middle East oil fields to the South West Asia and Far East. The degradation of oil involves both bacterial utilization and partial dissolution. The low boiling saturated hydrocarbon fractions of crude oil caused mortality in a wide variety of fish and shrimp fry. The worst cases were the larvae that nad deformed bodies and abnormal flexures of the tail, were unable to swim normally and most died within one day. The hydrocarbon content of the Indian seafood ranges from 0.6 to 3.0 mg/kg wet weight. (Author's abstract)
W91-10555 had deformed bodies and abnormal flexures of the

ECOLOGICAL MODELLING AT OSAKA BAY RELATED TO LONG-TERM EUTROPHICA-

Japan NUS Co. Ltd., Tokyo. For primary bibliographic entry see Field 5C. W91-10556

SIMULATION OF BIOECOLOGICAL AND WATER QUALITY PROCESSES IN ENCLOSED COASTAL SEAS.

Halcrow (William) and Partners, Swindon (England) For primary bibliographic entry see Field 5C. W91-10557

MARICULTURE AND EUTROPHICATION IN

JINHAE BAY, KOREA.
Department of Aquaculture, Tong-yeong Fisheries
Technical College, Chungmu 650-160, Korea.

C. H. Cho.
Marine Pollution Bulletin MPNBAZ, Vol. 23, p 275-279, 1991. 1 fig, 1 tab, 14 ref.

Descriptors: \*Aquaculture, \*Eutrophication, \*Fisheries, \*Industrial wastes, \*Jinhae Bay, \*Korea, \*Marine pollution, \*Municipal wastes, \*Path of pollutants, \*Wastewater pollution, \*Water pollution sources, Algal blooms, Chemical oxygen demand, Diatoms, Flagellates, Masan Harbor, Mortality, Mussels, Nutrient concentrations, Oysters, Red tide, Seaweeds, Sulfides, Water pollution control.

Jinhae Bay, the largest bay in Korea, was once a Jinhae Bay, the largest bay in Korea, was once a productive area for fisheries. From the industrial area around Masan Bay, approximately 200 cu m waste per day discharges into the bay, about 75% of that comprising municipal sewage. In addition, 711 kl human wastes flows into the bay, with about half remaining untreated. Chemical oxygen demand, phosphorus and sulfide contents increased demants, prospined and admit contents increased for the last decade (from 1972 to 1982). Mariculture in Korea (mostly in seaweed, oysters, mussels, arkshells) increased almost eightfold for the last two decades. Red tides have frequently occurred, with more than 50% of the red tides located in Jinhae Bay. Causative organisms of red tides shifted from diatoms to flagellates. A decrease in shell-fish production and mass mortality of other organisms was caused by a high level of eutrophication, resulting from both waste discharges from an industrial complex and organic deposits from aquaculture. Potential pollution control measures include widescale dredging in the Masan Harbor and cleaning of bottom deposits in aquaculture grounds with specially-designed boats. (Brunone-PTT) W91-10558 with more than 50% of the red tides located in

STUDIES ON THE SITUATION OF POLLUTION AND COUNTERMEASURES OF CONTROL OF THE OCEANIC ENVIRONMENT IN ZHOUSHAN FISHING GROUND: THE LARG-EST FISHING GROUND IN CHINA

Chinese Academy of Beijing.

For primary bibliographic entry see Field 5C. W91-10559

INCIDENCE AND ECOLOGY OF MARINE FOULING ORGANISMS IN THE EASTERN HARBOUR OF ALEXANDRIA, EGYPT. Institute of Oceanography and Fisheries, Alexan-

For primary bibliographic entry see Field 5C.

MAN-MADE GARBAGE POLLUTION ON THE MEDITERRANEAN COASTLINE.

Food and Agriculture Organization of the United Nations, Athens (Greece). Mediterranean Action Plan Project Office. G. P. Gabrielides, A. Golik, L. Loizides, M. G.

Marino, and F. Bingel.
Marine Pollution Bulletin MPNBAZ, Vol. 23, p
437-441, 1991. 2 fig, 2 tab, 11 ref.

ors: \*Beach contamination, \*Cyprus,
\*Italy, \*Litter, \*Mediterranean Sea, Descriptors:

\*Sicily, \*Spain, \*Turkey, \*Waste disposal, \*Water pollution sources, Coastal waters, Coastal zone management, Environmental monitoring, Seasonal

Measurements of persistent litter on 13 beaches in Spain, Italy (Sicily), Turkey, Cyprus and Israel between 1988 and 1989 show that plastic items are the most abundant in the litter composition, folthe most adminant in the fitter composition, rot-lowed by wood, metal, and glass items. Remnants of fishing gear are rather rare. The quantity of litter on a beach is inversely related to its geo-graphical distance to a population center and di-rectly related to its number of visitors. Seasonal fluctuations in coastal litter are caused by storm waves which wash the litter landward, leaving the waves which wash the litter landward, leaving the beach clean during winter, and by bathers who pollute the beach during summer. Based on the nature of the garbage, most Mediterranean coastal litter is land-based, in contrast to the reported marine-based litter on the western European shores. (Author's abstract) W91-10569

INTEGRATED MANAGEMENT OF THE

National Swedish Environment Protection Board,

For primary bibliographic entry see Field 5G. W91-10580

FORMATION OF OXYGEN-DEFICIENT WATER MASS IN OMURA BAY.

Nagasaki Prefecture Inst. of Health Science and Envirnomental Science (Japan).

S. Akagi, and F. Hirayama.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 661-663, 1991. 5 fig, 1 ref.

Descriptors: \*Anoxic conditions, \*Japan, \*Omura Bay, \*Oxygen depletion, \*Path of pollutants, \*Thermal stratification, \*Water circulation, \*Water pollution effects, Algal blooms, Ammonia, Nutrient concentrations, Phosphates, Red tide, Seasonal distribution, Sediment contamination.

Omura Bay is a typical enclosed inner bay. Thermal stratification begins gradually in the central part of the bay in May when the water temperatures increase between the surface and the bottom water. Oxygen-deficient water in the bottom layer is renewed every summer. In August, the degree of oxygen deficiency is highest. Nutrients (phosphate phosphorus and ammonia nitrogen) are released from the bottom sediments under these anaerobic conditions. The water circulation begins in Octo-ber and November. The anaerobic condition of the water is sometimes influenced by wind. Low dis-solved oxygen concentration in the surface water solved oxygen concentration in the surrace water was observed when an upwelling of oxygen deficient water was caused by a drift current. Formation of oxygen deficient water masses during the summer influences marine organisms in the bay. The circulation of the water mass in autumn accelerates the occurrences of red tides. (Author's absence) stract) W91-10592

EUTROPHICATION MECHANISMS OF COASTAL SEAS IN YAMAGUCHI PREFEC-

Yamaguchi Prefectural Research Inst. of Health (Japan).

K. Tanaka, Y. Imatomi, K. Saeki, S. Furutani, and K. Torii.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 665-667, 1991. 1 fig, 5 tab, 6 ref.

Descriptors: \*Coastal waters, \*Eutrophication, \*Japan, \*Marine pollution, \*Path of pollutants, Dissolved oxygen, Domestic wastes, Industrial wastes, Organic pollutants, Primary productivity, Seto Inland Sea, Tokuyama Bay, Water circulation, Yamaguchi Prefecture.

Two different types of semi-enclosed, organically polluted bays were investigated in the northern part of the Sea of Suo, the Seto Inland Sea. One is Tokuyama Bay, surrounded by industrial complex-

#### Sources Of Pollution—Group 5B

es; the other is Yamaguchi Bay, seemingly affected mainly by household effluent draining through many rivers. Little sea water exchange was ob-served in Tokuyama Bay. During the summer, vertical mixing was weak, because of thermal stra-ification. Dissolved oxygen concentration was low ification. Dissolved oxygen concentration was low in the bottom water layer; primary production was constant throughout the year. In Yamaguchi Bay, the exchange rate of sea water was relatively high and the contribution of primary production to the organic pollution in the bay was small. Pollutant load by domestic sewage had a major influence on the sea water quality. (Author's abstract) W91-10593

COMPARISON OF NUTRITIONAL ENVIRON-MENT OF CLOSED COASTAL SEAS IN WEST-ERN KYUSHU

Seikai National Fisheries Research Inst., Nagasaki (Japan). For primary bibliographic entry see Field 2L. W91-10595

HEAVY METALS CONTAMINATION IN THE POLISH ZONE OF SOUTHERN BALTIC. Gdansk Univ. (Poland). Dept. of Marine Chemis-

K. Korzeniewski, and E. Neugebauer. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 687-689, 1991. 5 fig, 7 ref.

Descriptors: \*Baltic Sea, \*Bioaccumulation, \*Heavy metals, \*Marine pollution, \*Path of pollutants, \*Poland, \*Sediment contamination, \*Suspended solids, Atmospheric input, Baseline studies, Cadmium, Coastal waters, Copper, Lead, Rivers, Stream discharge, Water quality standards, Zinc.

A baseline study investigated the level of heavy metal contamination in abiotic (water, suspended matter, sediments) and biotic (fish, plankton) com-ponents of Baltic ecosystems in Polish coastal zones. Data was collected every year from 1980 to 1985. Concentrations of cardining and lead (stresszones. Data was confected every year from 1980 to 1985. Concentrations of cadmium and lead (atmospheric input), copper and zinc (river input) were elevated in coastal waters and the Gulf o' Gdansk. Enrichment factors in suspended matter varied from 10,000 to 1,000,000, in sediments from 100 to 100,000, and in plankton from 10,000 to 100,000. The content of heavy metals in fish did not exceed the national and international standards. (Author's abstract) W91-10597

SEWAGE TREATMENT AND DISPOSAL STRATEGIES IN GREECE.

Ministry of Physical Planning, Housing and Envi-ronment, Athens (Greece). For primary bibliographic entry see Field 5G. W91-10598

POLLUTANT TRANSPORT MONITORING AND PREDICTION BY MATHEMATICAL MODELLING: NORTH SEA AND ADJACENT

GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 699-702, 1991. 5 fig, 7 ref.

Descriptors: \*Estuaries, \*Marine pollution, \*Mathematical models, \*Model studies, \*Monitoring, \*North Sea, \*Path of pollutants, Continental shelf, Data acquisition, Field tests, Flow rates, Hydrodynamics, Tidal flats, Tidal rivers.

Pollution in the North Sea comes from various Pollution in the North Sea comes trom various sources: atmospheric deposition, riverine input, and direct discharge from industries or ships. An integrated concept is proposed, combining field observations and the application of numerical models for transport processes in tidal rivers, estuaries, and the North Sea. The observation system consists of highly sensitive devices operated in boats in rivers and estuaries to determine transport rates and net transport of water constituents. In situ measurements are combined with moored sys-

tems and analysis of samples. Hydrodynamic pa-rameters are measured by horizontal and vertical profiling. The numerical models are based on shal-low water equations and solved by a finite differ-ence scheme. They use an implicit formulation of the free surface variation and allow for an economic time stepping procedure and treat flooding and falling dry of tidal flats. Transport of conservative taling dry of toda hats. Iransport of conservative substances is simulated using a tracer random walk technique. Transport of non-conservative substances can be achieved with a one-dimensional model of the upper part of the estuary. The suspended matter transport model uses current fields computed by a three-dimensional, time-dependent model of the northwest European shelf sea. (Brun-

CONSTRUCTION OF ARTIFICIAL SEAWEED BED ACCOMPANIED WITH THE RECLAMATION FOR UNIT NO. 3 OF IKATA POWER STATION.

Shikoku Research Inst., Inc., Takamatsu (Japan). For primary bibliographic entry see Field 2L. W91-10603

SEASONAL CHANGES OF ORGANIC CARBON AND NITROGEN PRODUCTION BY PHYTOPLANKTON IN THE ESTUARY OF RIVER TAMAGAWA.

nitama Univ., Urawa (Japan). Coll. of Liberal

Y. Yamaguchi, H. Satoh, and Y. Aruga. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 723-725, 1991. 3 fig, 1 tab, 3 ref.

Descriptors: \*Estuaries, \*Fate of pollutants, \*Japan, \*Nitrogen, \*Organic carbon, \*Phytoplankton, \*Seasonal variation, \*Tamagawa River, Chlorophyll a, Nutrient concentrations, Photosynthesis, Primary productivity.

onal changes of organic carbon and nitrogen Seasonal changes of organic carbon and introgen production were investigated at a station in the estuary of Tamagawa River in Tokyo Bay, Japan to evaluate the role of phytoplankton as a sink of inorganic nutrients flowing into the estuary from the surrounding land areas. Standing stock of phytoplankton expressed as a concentration of chloro-phyll a and their photosynthetic activities fluctuatphyll a and their photosynthetic activities fluctual-ed significantly with sampling periods. Based on the data obtained in 1988 and 1989, the levels of annual production of organic carbon and nitrogen by the phytoplankton community in the estuary were estimated to be 1890 g C/sq m/year and 281 g N/sq m/year, respectively. (Author's abstract) W91-10604

COAL MINE WATERS AND THEIR INFLU-ENCE ON THE PURITY ECOLOGICAL STATE OF RIVER AND THE FISH PRODUCTION

OF REVER AND THE FISH PRODUCTION.
Akademia Rolnicza, Lublin (Poland). Dept. of Zoology and Hydrobiology.
S. Radwan, C. Kowalczyk, B. Jarzyna, A.
Paleolog, and W. Zwolski.
Marine Pollution Bulletin MPNBAZ, Vol. 23, p
733-736, 1991. 1 fig. 5 ref.

Descriptors: \*Coal mining effects, \*Fish mortality, \*Fisheries, \*Poland, \*Salinity, \*Water pollution sources, Aquatic animals, Biomass, Chlorides, Comparison studies, Invertebrates, Population density, Species diversity, Swinka River, Water chemistry, Wieprz River.

The ecological quality of coal mine waters as investigated in Lubin Coal Basin, eastern Poland. The waters collected in a mining reservoir and flowed into the small rivers Swinka and Wieprz. flowed into the small rivers Swinka and Wieprz. These waters were of medium-level salinity, mainly chlorides, with an average of 834 mg/L to 922 mg/L concentration. Fairly high species diversity was noted in the reservoir, represented by 31 taxa of invertebrates and 10 species of fish. Fish reached maximal annual weight and length gains, usually higher than in other waters in Poland. The high chloride content in the coal mine waters exerted negative effects on the chemical composition and the zoocenosis of the Swinka and Wieprz rivers. The overall species diversity decre

while the eurytopic and euryhaline species in-creased. The slightly saline coal mine waters were generally suitable for fish production, considering both species composition and fish growht. (Au-thor's abstract) W91-10605

EAST ASIAN SEAS: HYPOTHETICAL OIL SPILL TRAJECTORIES,

source Systems Inst., Honolulu, HI. M. J. Valencia.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 753-757, 1991. 2 fig, 4 ref.

Descriptors: \*Coastal waters, \*East China Sea, \*Japan, \*Marine pollution, \*Mathematical models, \*Model studies, \*Monsoons, \*Oil spills, \*Path of pollutants, \*Sea of Japan, International agreements, International waters, Water circulation.

Hypothetical oil spill trajectories are projected for ryporteneas or spin trajectories are projected for each monsoon from four locations near Japan: the central and southern Sea of Japan, and the north-ern and southern East China Sea. Actual and possi-ble maritime jurisdictional boundaries were superimposed on these trajectories. The trajectories indi-cate the distance of travel from the site in three day intervals, usually up to thirty days, or until little further movement is expected. The models include the effects of regional currents, circulation patterns derived from simplified circulation models of the region, statistical or climatological winds, and a hypothetical weathering process for an inter-mediate weight crude oil. Spills at most sites would soon cross international jurisdictional boundaries and may eventually reach a sometimes estranged neighbor's coast. These results indicate that cooperation is necessary among East Asian countries to minimize the effects of such a spill. (Brunone-PTT) W91-10608

COMPUTER VISUALIZATION SYSTEM FOR SEDIMENT POLLUTION IN JAPAN.

Chiba Inst. of Tech., Narashino (Japan). Dept. of

Civil Engineering.
For primary bibliographic entry see Field 7C.
W91-10609

CAUSES OF WATERBORNE OUTBREAKS IN THE UNITED STATES.

Environmental Protection Agency, Cincinnati, OH. G. F. Craun.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 17-20, 1991. 5 fig, 1 tab.

Descriptors: \*Epidemiology, \*Human diseases, \*Pathogens, \*Public health, \*Water distribution, \*Water pollution sources, \*Water treatment, Bacteria, Contamination, Disinfection, Escherichia coli, Filtration, Giardia, Maintenance, Missouri, Parasites, Rotaviruses, Viruses.

During 1981-1988 in the United States, 248 water-During 1961-1968 in the United States, 2-86 water-borne outbreaks occurred in community (45%) and noncommunity (34%) water systems and from the ingestion of contaminated water from individual (11%) and recreational (10%) water sources. The (11%) and recreational (10%) water sources. In ease of contaminated, untreated groundwater or inadequately disinfected groundwater was responsible for 44% of the waterborne outbreaks reported during this period. The use of contaminated, untreated surface water or inadequately treated surface water was responsible for 26% of the outbreaks during this period. Contamination of the distributions and the contamination of the distributions and the contamination of the distributions. distribution system, primarily through cross-con-nections and repair of mains, caused 13% of the nections and repair of mains, caused 13% of the outbreaks. The remaining outbreaks were caused by miscellaneous and undetermined deficiencies. During 1981-1985, a dramatic increase in outbreaks occurred in filtered water systems, underscoring the importance of proper design and operation of filtration facilities. Since the 1940s, most water-borne outbreaks resulted in acute gastroenteritis of undetermined etiology, representing a combination undetermined etiology, representing a combination of viral, bacterial, and parasitic etiologies. Recognized waterborne pathogens include Norwalk agent, rotavirus, Campylobacter, Yersinia, Giardia, and Cryptosporidium. Enterohemorrhagic E. coli

#### Group 5B-Sources Of Pollution

0157:H7 was recently identified as the cause of a possible waterborne outbreak in Missouri. (See also W91-10612) (Doria-PTT)

PROSPECTIVE EPIDEMIOLOGICAL STUDY OF DRINKING WATER RELATED GASTROIN-TESTINAL ILLNESSES,

TESTINAL ILLNESSES.
Institut Armand-Frappier, Laval (Quebec).
P. Payment, L. Richardson, M. Edwardes, E. Franco, and J. Siemiatycki.
Water Science and Technology WSTED4, Vol. 24, No. 2, p 27-28, 1991.

Descriptors: \*Drinking water, \*Epidemiology, \*Human diseases, \*Public health, \*Water pollution effects, \*Water quality standards, \*Water treat-ment, Filters, Filtration, Microbiological studies, Reverse osmosis, Surveys, Water distribution.

A prospective epidemiological study was undertaken to evaluate whether drinking water satisfying current quality standards nevertheless causes gastrointestinal illness. The study consisted of a health surveillance of 600 randomly chosen househealth surveillance of 600 randomly chosen house-holds (2,400 individuals) and of the microbiological analysis of tap water from the filtration plant and its distribution system. Half of the households were randomly assigned to the tap water subgroup and half to a control subgroup. A reverse osmosis filter was installed in each control household, thereby was installed in each control household, thereby ensuring a very low microbiological pollution level. Each member of each household reported gastrointestinal symptoms on a bimonthly health calendar during two periods. The incidence of highly credible gastrointestinal symptoms (HCGI) was markedly different in the two groups. During the first period the incidence of episodes/year was 0.82 in the group consuming filtered water and 1.13 among those consuming the respectively 0.47 except prior these values were respectively 0.47. 1.13 among those consuming fap water. During the second period these values were respectively 0.47 (filter) and 0.62 (tap). Differential incidence rates of HCGI between the two groups were observed in all age and sex groups. While tap water met acceptable standards of quality, these results indicate that there was a 25% excess of gastrointestinal illness in the group consuming the water. Further analysis of the water quality and of the integrity of the distribution system are underway. Serum samples are also being analyzed. (See also W91-10612) (Author's abstract)

STAPHYLOCOCCI IN POLLUTED WATERS AND IN WATERS OF UNINHABITED AREAS, National Board of Waters and the Environment, Helsinki (Finland).

J. Ahtiainen, M. Niemi, and H. Jousimies-Somer. Water Science and Technology WSTED4, Vol. 24, No. 2, p 103-108, 1991. 3 fig, 3 tab, 15 ref.

Descriptors: \*Fecal bacteria, \*Path of pollutants, \*Rural areas, \*Staphylococcus, \*Water pollution sources, Culture media, Finland, Lakes, Streams, Survival, Wastewater.

The occurrence of staphylococci was studied in The occurrence of staphylococci was studied in southern Finland using both the modified Vogel-Johnson (VJP) and the M-5LSMA media in the MF technique. The study involved brooks and small lakes in uninhabited areas and sparsely populated farming areas as well as effluents from sewage treatment plants. Fecal indicator bacteria were determined simultaneously in all samples. Median colony counts on both of the staphylococal media in 100 ml samples were 1 to 2 for uninhabited areas, 60 to 110 for agricultural areas, and 1,000 to 1,600 for treated wastewater. The maximum values were much higher in all the enviand 1,000 to 1,600 for treated wastewater. The maximum values were much higher in all the environments. The M-5LSMA recovered at least as many staphylococci as the VJP medium, but was more selective. Strains isolated from pristine waters and from wastewater were identified with the API 20 Staph kit. Six different species of staphylococci were recovered on the VJP medium and ten on the M-5LSMA medium. About one-third of the isolates from wastewater were Staphylococcus areus, whereas 1896 of the isolates from lococcus aureus, whereas 18% of the isolates from uninhabited areas belonged to this species. The identification was confirmed with the coagulase and DNAase tests. Different survival and adher-

ence properties between staphylococci and fecal indicators may explain the higher staphylococci/ fecal indicator ratio in cleaner waters than in treated sewage. The origin of staphylococcal contami-nation and the evaluation of the indicator value of w91-10631
W91-20631

STUDIES ON THE BACTERIAL FAUNA OF THE TAMAGAWA RIVER, Meiji Coll. of Pharmacy, Tokyo (Japan). Dept. of Microbiology.

T. Arai.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 109-112, 1991. 5 tab, 1 ref.

Descriptors: "Path of pollutants, "Stream biota, \*Tamagawa River, \*Water pollution sources, Ag-ricultural runoff, Arsenic, Bacteria, Coliforms, Fish farming, Heavy metals, Japan, Mercury, Pes-ticides, Seasonal variation, Wastewater treatment.

Bacteria of the Tamagawa River near Tokyo were studied to assess contamination from different sources. Water from 8 sampling points was examined in spring, summer, and autumn. Bacteria were distinguished by their colony forms on selective media containing various drugs, including mercuric chloride (Hg), sodium arsenate (As), furazolidone (NF), streptomycin, kanamycin, chloramphenicol, tetracycline, ampicillin, and sodium dependent of the strength of the stre phenicol, tetracycline, ampicillin, and sodium do-decyl sulfate. Pollution from fecal materials was determined using coliforms and Enterococcus. The major part of these bacteria came from human sources and not from domestic animals. Hg and As sources and not roll domestic administ. If and As are used as pesticides; NF is used mostly for fish. The high incidence of NF-resistant bacteria in spring could be an indication of high activity of hatcheries. Some of the heavy-metal-resistant bacnatcheres. Some of the neavy-metal-resistant bac-teria could come from soil, transported by summer rains, because these pesticides are used in agricul-tural fields in the late spring and summer after the rice fields have been drained. Results suggest that general bacteria in the Tamagawa River originate mainly from fish culturing and agriculture, and that coliform bacteria are mainly of human origin. Wastewater treatment seemed to be effective in reducing bacterial contamination. It is hoped that reacting outcome contamination. It is hoped that this investigation will lead to the development of a new system for the detection of river water pollu-tion. (See also W91-10612) (Doria-PTT) W91-10632

BACTERIAL WATER QUALITY IN URBAN RECEIVING WATERS, Middlesex Polytechnic, Enfield (England). Urban Pollution Research Center.
J. L. Jacobs, and J. B. Ellis.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 113-116, 1991. 4 fig. 7 ref.

Descriptors: \*Path of pollutants, \*Receiving waters, \*Urban areas, \*Urban watersheds, \*Water pollution sources, \*Water quality standards, Bacteria, Benthic environment, Bioindicators, Coliforms, England, Fecal bacteria, London, Microorganisms, Pathogens, Public health, Risk assessment, Salmonella, Sediments, Storm runoff, Streptococcus.

A health risk assessment was conducted for an urban catchment located in the northwestern fringes of metropolitan London, England. Monthly samples of water and sediment were analyzed for samples of water and securities were analyzed to total and fecal coliforms, fecal streptococci, and selected pathogens. The waters within the Silk Stream catchment were judged to be severely pol-luted, and can exceed the European Economic theet, and can exceed the European Economic Community (EEC) guideline limits for both total and fecal coliforms, fecal streptococci, and Salmonella throughout the study area during storm flows. The EEC guideline limit for fecal coliforms of 100 MPN/100 ml is exceeded more than 80% of of 100 MPN/100 ml is exceeded more than 80% of the time with rainfall depths of as little as 5 mm. At rainfall depths of 20 mm, the mandatory limit of 2,000 MPN/100 ml is exceeded half of the time. The likelihood of quickly and easily reducing the bacterial load within urban situations is small, given the lack of retention and treatment facilities for large volumes of storm water. However, microorganisms eventually resettle downstream as well as in the flood storage basin, reducing the well as in the flood storage basin, reducing the water population to background prestorm values. The bacterial population is probably sedimented into the protected environment of the benthal sludge until the next storm flow event. Resuspension increases the probability of intermittent release of microorganisms into the water column, although there will be a dilution effect in the receiving basin. This should help reduce any health risk, although more work is needed to quantify such risks. (See also W91-10612) (Doria-PTT) W91-10632

STUDY OF CAMPYLOBACTER IN SEWAGE, SEWAGE SLUDGE AND IN RIVER WATER. Forschungsinstitut fuer Mikrobiologie und Hygiene, Bad Elster (German D.R.). For primary bibliographic entry see Field 5D. W91-10634

RELATIONSHIP BETWEEN PSEUDOMONAS AERUGINOSA AND BACTERIAL INDICA-TORS IN POLLUTED NATURAL WATERS. Malaga Univ. (Spain). Facultad de Ciencias. For primary bibliographic entry see Field 5A. W91-10635

ENUMERATION OF MOTILE AEROMONAS IN VALENCIA COASTAL WATERS BY MEM-BRANE FILTRATION.

Universidad Politecnica de Valencia (Spain), Inst. of Hydrology and Environment.

J. L. Alonso, I. Amoros, and M. S. Botella.

Water Science and Technology WSTED4, Vol.

24, No. 2, p 125-128, 1991. 5 tab, 18 ref.

Descriptors: "Aeromonas, "Bacterial analysis, "Coastal waters, "Membrane filters, "Path of poliutants, "Spain, "Water analysis, "Water pollution sources, Bacteria, Coliforms, Culturing techniques, Fecal coliforms, Feces, Public health, Recreation, Seasonal variation, Temperature, Valencia,

Levels of motile Aeromonas were monitored in marine recreational waters influenced by sewage discharges north of Valencia (Spain). Microorgadischarges north of Valencia (spain). Microorga-nisms were enumerated by membrane filtration, using mADA/0129 agar. Motile Aeromonas were recovered from all samples. The highest counts of aeromonads (22,200 to 9 million cfu/100 ml) were obtained at Puebla de Farnals, where coliforms were also high, indicating fecal contamination. Th lowest aeromonad counts were detected at Puzol. lowest aeromonau counts were detected at ruzon. Motile Aeromonas and total coliforms exhibited similar cell densities and fluctuations throughout the sampling period. The number of aeromonads exceeded fecal coliforms throughout the year. The exceeded fecal coliforms throughout the year. The population of aeromonads did not exhibit seasonal fluctuations, and was independent of environmental temperatures for most sampling sites. The most frequent species identified were A. caviae, followed by A. hydrophila and A. sobria. Epidemiological studies are needed to determine the specific public health significance of aeromonads in marine recreational waters. (See also W91-10612) (Doria-TTT). W91-10636

PROTECTIVE EFFECT OF GLYCINE BETA-INE ON SURVIVAL OF ESCHERICHIA COLI CELLS IN MARINE ENVIRONMENTS.

Institut National de la Sante et de la Recherche Medicale, Nice (France). Unite 303 Mer et Sante. M. J. Gauthier, G. N. Flatau, and V. A. Breittmaver.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 129-132, 1991. 1 fig, 17 ref.

Descriptors: \*Bacterial physiology, \*Bioindicators, \*Escherichia coli, \*Glycine betaine, \*Marine environment, \*Survival, Bioaccumulation, Genetics, Marine sediments, Nutrients, Organic carbon, Sea-

Bacteria entering the sea are subjected to an immediate osmotic upshock. Their ability to overcome this shock by means of osmoregulatory systems

#### Sources Of Pollution-Group 5B

influences their survival in marine environments. Glycine betaine (GB) is a very potent osmoprotectant for some bacteria. In Escherichia coli, an increase of external osmolarity induces a strong stimulation of GB uptake. Two distinct GB transstimulation of GB uptake. Two distinct GB transport systems have been characterized in this species: ProP and ProU. The influence of osmoregulation processes on the survival of E. coli in seawater and sediments was investigated using strains harboring proP-lacZ and proU-lacZ gene or operon fusions. The uptake of GB and the expression of both proP and proU were found to be weak in seawater. In marine sediments, proP expression was weak, and GB uptake and proU expression were variable, probably depending on the availability of nutrients. In sediment with high total organic carbon content, GB uptake was very high and proU expression enhanced; cells previously incubated in this sediment showed a higher resistince of the property of the proposition organic caroon content, OB uptake was very mgn and proU expression enhanced; cells previously incubated in this sediment showed a higher resist-ance to decay in seawater. Results show that GB can be accumulated from raw sediments (due to the stimulation of GB uptake and proU gene ex-pression) and that GB accumulation is followed by protective state, allowing cells to survive longer then later starved in seawater. (See also W91when later starved 10612) (Doria-PTT)

EFFECT OF DISSOLVED NUTRIENTS AND INORGANIC SUSPENDED SOLIDS ON THE SURVIVAL OF E. COLI IN SEAWATER. Clyde River Purification Board, East Kilbride

Clyde River Full Canada.

(Scotland).

D. P. Milne, J. C. Curran, J. S. Findlay, J. M.

Crowther, and J. Bennet.

Water Science and Technology WSTED4, Vol.

24, No. 2, p 133-136, 1991. 2 fig, 9 ref.

Descriptors: \*Bacterial physiology, \*Bioindicators, \*Escherichia coli, \*Nutrients, \*Survival, \*Suspended solids, Bacteria, Culture media, Glucose, Inorganic compounds, Peptone, Salinity, Seawater, Temperature.

The effect of dissolved nutrients and inorganic suspended solids on Escherichia coli inactivation was examined in laboratory experiments. The study used artificial seawater with dissolved glustudy used artificial seawater with dissolved gui-cose and peptone, laboratory-processed suspended solids, and chemostat steady state E. coli cultures to establish the effect of these parameters on the viability of an E. coli population. Initial E. coli concentration was 5,000/100 ml, the temperatures 5 C and 20 C, the suspended solids concentration range was 0-100mg/L, glucose concentration 1.0 mg/L pertone concentration 9.0 mg/L salinity. range was 0-100mg/L, glucose concentration 1.0 mg/L, speptone concentration 9.0 mg/L, salinity range 27-32%, and the experimental vessels were shielded from light. It has been shown that nutrient-free inorganic suspended solids, at low concentrations, markedly increased the survival of E. coli in seawater. Results of the present study indicate that the presence of dissolved nutrients greatly increases E. coli survival in the absence of suspended solids. However, survival time was greatly reduced at suspended solids concentrations of >5-12 mg/L. thereafter, increasing suspended solids 12 mg/L; thereafter, increasing suspended solids concentration in the range > 12.5-100 mg/L generally resulted in increased survival times. (Author's

OCCURRENCE OF LEGIONELLA BACTERIA IN COOLING TOWERS IN SOUTH AFRICA.
Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology. N. A. Grabow, E. J. Pienaar, and R. Kfir. Water Science and Technology WSTED4, Vol. 24, No. 2, p 149-152, 1991. 2 fig. 7 ref.

Descriptors: \*Cooling towers, \*Legionella, \*Path of pollutants, \*Pathogenic bacteria, \*South Africa, Descriptors: \*Cooling towers, \*Legioneua, rain of pollutants, \*Pathogenic bacteria, \*South Africa, Bacteria, Bacterial analysis, Biocides, Contamination, Immunoassay, Infection, Maintenance, Most probable number test, Public health, Surveys, Water analysis, Water quality standards.

A total of 510 service water samples from cooling towers throughout South Africa were analyzed for the presence of Legionella bacteria. Legionella was detected using an immunolabelling technique based on the most probable number principle. Only

viable bacteria were counted. Legionella bacteria were detected in about 77% of the samples. The majority of the samples were found to have counts between 10 and 500 legionella/ml. In only 4% of the samples were counts higher than 2,200/ml. These results indicate mild levels of contamination These results indicate mild levels of contamination of the majority of the cooling towers. However, it has been reported that such levels can increase drastically within days or weeks under favorable conditions. No guidelines exist for Legionella, and the infectious dose in unknown; therefore, one should aim for the lowest possible counts of legionshould anti for the lowest possible counts of legion-ellae in the maintenance of cooling towers. The fact that about 32% of the samples were found to have no Legionella bacteria indicates that such maintenance can be achieved. The biocide treatmaintenance can be achieved. The blocide treat-ment of 28 cooling towers was found to be highly efficient for Legionella removal. After 3 months' treatment, 67% of the samples tested had no Le-gionella bacteria, while only 10.7% of the samples still had more than 10 bacteria/ml. No correlation still had more than 10 bactera/mi. No correlation could be found between Legionella counts and standard plate counts, suggesting that the use of standard plate counts is impractical and possibly misleading as an indication of Legionella levels in cooling towers. (See also W91-10612) (Doria-PTT) W91-10641

GROWTH AND INACTIVATION KINETICS OF MYCOBACTERIA IN BIOFILMS.

MYCOBACIERIA IN BIUFILIMS.
Bonn Univ. (Germany, F.R.). Hygiene Inst.
R. Schulze-Robbecke, and R. Fischeder.
Water Science and Technology WSTED4, Vol.
24, No. 2, p 153-156, 1991. 4 fig, 1 tab, 6 ref.

Descriptors: \*Aquatic bacteria, \*Bacterial growth, \*Biofilms, \*Mycobacterium, \*Pathogenic bacteria, Colonization, Kinetics, Polymers, Population density, Silicone tubing, Survival. sity, Silicone tubing, Surviv

Surfaces within aquatic habitats may be colonized by large quantities of mycobacteria. The growth kinetics and colonization patterns of biofilm myco-bacteria were studied under controlled conditions in two silicone tube systems perfused in two differ-ent periods. In one model system, the density of mycobacterial surface colonization reached a denmycobacterial surface colonization reached a density of more than 100,000 cfu per sq cm after 52 days and of 1 million cfu per sq cm after 10 weeks. The mycobacteria found in the model systems included opportunist pathogens such as Mycobacterium kansasii. Biofilms should therefore be considered for inclusion in the study of health-related environmental mycobacteria. The inactivation rates of the in situ biofilm mycobacteria studied in these extensions with the control of the contro rates of the in situ biofilm mycobacteria studied in these experiments were not or only slightly inferior to those of suspended mycobacterial isolates from the same biofilm. These findings indicate that the general chemical resistance of mycobacteria (which is due to their specific cell wall structure) is not significantly enhanced by their integration into biofilms and protection by bacterial exopolymers. Further studies are needed for statistical confirmation and practical applications of these findings. (See also W91-10612) (Doria-PTT) W91-10642

EPIDEMIOLOGY OF HUMAN CRYPTOSPOR-IDIOSIS AND THE WATER ROUTE OF IN-FECTION.

FECTION.
Public Health Laboratory Service Cryptosporidium Reference Unit, Public Health Laboratory, Glan Clwyd Hospital, Bodelwyddan, Rhyl, Clwyd, LL18 5UJ, Wales.
D. P. Casemore.
Water Science and Technology WSTED4, Vol. 24, No. 2, p 157-164, 1991. 12 ref.

Descriptors: \*Cryptosporidium, \*Epidemiology, \*Infection, \*Parasites, \*Path of pollutants, \*Protozoa, Chlorine, Disinfection, Distribution, Feces, Human diseases, Irrigation, Land disposal, Life cycles, Livestock, Ozone, Pathogens, Water pollution effects, Water quality standards, Water treatment.

Cryptosporidium, a protozoan parasite, has emerged during the 1980s as a common cause of gastroenteritis in otherwise healthy subjects and of potentially life-threatening infection in the immun-ocompromised. The parasite, a member of the coc-

cidia, has a complex life cycle resulting in the production of an environmentally hardy stage, the oocyst, excreted in the feces. Cryptosporidium occyst, excreted in the leves. Cryptosportation parvum has a worldwide distribution and infects a wide range of host species including man and livestock. The epidemiology is complex with both direct and indirect routes of transmission. Environinvestock. The epidemiology is compiex with both direct and indirect routes of transmission. Environmental contamination may result in dissemination of infection by water. The widespread practice, even in advanced countries, of disposing of both and animal and human excreta to land, such as by muck and slurry spreading on pasture, may lead to infection directly by aerosol spread during application, or indirectly by contamination of water courses and reservoir feeder streams. Surface waters polluted naturally or by these practices may lead to contamination of water supplies or of food crops during irrigation. Such water may meet current microbiological and other standards. The cocysts are remarkably resistant to most disinfectants including chlorine, but sensitive to ozone. Water may provide the vehicle of infection for sporadic cases and outbreaks, some involving thousands of consumers. The microbiological parameters for covaluating water safety can no longer be relied on to guarantee freedom from risk of infection. (See also W91-10612) (Doria-PTT) W91-10643

OCCURRENCE OF CRYPTOSPORIDIUM SPP. OCCYSTS IN SCOTTISH WATERS, AND THE DEVELOPMENT OF A FLUOROGENIC VIA-BILITY ASSAY FOR INDIVIDUAL CRYPTO-SPORIDIUM OOCYSTS.

Scottish Parasite Diagnostic Lab., Glasgow. H. V. Smith, A. M. Grimason, C. Benton, and J. F. W. Parker.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 169-172, 1991. 3 fig, 1 tab, 6 ref.

Descriptors: \*Cryptosporidium, \*Parasites, \*Pol-lutant identification, \*Protozoa, \*Scotland, \*Water analysis, Dyes, Growth stages, Immunoassay, Morphology, Oocysts, Path of pollutants, Patho-gens, Seasonal variation.

A total of 262 water-related samples were analyzed for the presence of Cryptosporidium spp. oocysts, of which 39,3% were positive, over a 12-month period. Similar data were obtained for their occurrence in samples of both raw and treated water from Scotland, with 40,5% of raw water and 40,1% of treated water being positive. Fewer oocysts were detected in the summer than in the autumn, winter, or spring. In a 12-month survey of water used for abstraction, oocysts were detected at various times throughout the year in both raw and treated water. A series of conventional and fluorogenic dyes was used, in conjunction with a fluorescent labelled monoclonal antibody, in an attempt to assess their potential for improving the identification of oocysts in water-related samples. attempt to assess their potential for improving the identification of occysts in water-related samples. The conventional dyes tested can be used in conjunction with a labelled monoclonal antibody to define both morphometrics and internal structures, thus aiding the identification of individual occysts. Increasing the permeability of oocysts with detergents enhanced the penetration of these dyes into sporozoites. Whereas the fluorescein, auramine, and rhodamine dyes tested highlight sporozoites and rhodamine dyes tested mignight sporozoites predominantly, under certain conditions the occyst wall could also be highlighted. Propidium iodide readily penetrated dead sporozoites and heat-killed oocysts. DAPI, auramine, and rhodamine dyes penetrated oocysts excysted in vitro. (See also W91-10612) (Doria-PTT) W91-10645

DETERMINING GIARDIASIS PREVALENCE BY EXAMINATION OF SEWAGE.

Environmental Monitoring Systems Lab., Cincinnati. OH. For primary bibliographic entry see Field 5A. W91-10646

OCCURRENCE AND VIABILITY OF GIARDIA SPP. CYSTS IN UK WATERS. Scottish Parasite Diagnostic Lab., Glasgow. R. A. Gilmour, H. V. Smith, P. G. Smith, G. P.

#### Group 5B-Sources Of Pollution

Morris, and R. W. A. Girdwood. Water Science and Technology WSTED4, Vol. 24, No. 2, p 179-182, 1991. 1 fig, 2 tab, 12 ref.

Descriptors: "Giardia, "Parasites, "Path of pollut-ants, "Pollutant identification, "Protozoa, "United Kingdom, "Water analysis, Assay, Dyes, Effluents, Potable water, Recreation, Seasonal variation, Wastewater.

Modifications of the existing methods for the isolation of Giardia spp. cysts from water enabled up to 33% of seeded cysts to be recovered. Using this method, 263 environmental samples were analyzed for the presence of cysts, of which 34.4% were positive. All sewage effluents, 85% of recreational waters, 46% of raw potable water samples, and 22% of treated water samples contained cysts (range 0.14-359/L.) Maximum cyst levels were higher in treated compared with untreated waters, but average concentrations of positive samples but average concentrations of positive samples were higher in untreated compared with treated waters. The maximum number of cysts detected in recreational waters was over 10 times that detected in raw water, whereas sewage effluent peak levels were over 1,000 times and 100 times the maximum cyst levels detected in treated and recreational waters, respectively. A higher percentage of positive samples occurred in the summer and autumn in raw water, whereas the levels of cysts in treated waters showed little seasonal variation. A fluoro-genic vital dye assay, which compares favorably with in vitro excystation, was developed, and, using this assay, viable cysts were detected in 33% usang suns assay, vadite cysts were detected in 33% of the positive raw water samples and 42% of the positive treated water samples. (See also W91-10612) (Doria-PTT) W91-10647

WASTEWATER AND GIARDIA CYSTS.

WASIEWAIER AND GIARDIA CYSIS.
Departement de Microbiologie, WHO Collaborating Centre, Faculte de Pharmacie, 5 rue Albert Lebrun, \$4000 Nancy, France.
L. Gassmann, and J. Schwartzbrod.
Water Science and Technology WSTED4, Vol. 24, No. 2, p 183-186, 1991. 1 fig, 3 tab, 12 ref.

Descriptors: \*France, \*Giardia, \*Parasites, \*Path of pollutants, \*Protozoa, \*Public health, \*Wastewater analysis, Nancy, Seasonal variation, Temporal distribution, Wastewater, Wastewater

Giardia cysts were searched for in raw wastewater taken at the entrance of the treatment plant in Nancy (France), after concentration by the Bai-Nancy (France), after concentration by the Bal-lenger method and quantification by Thoma cell counting. Parameters studied include sampling time, sampling day, and sampling month. An anal-ysis of hourly variation showed that the concentra-tion of Giardia cysts ranged from 9,500 to 14,000/ 1. concentrations in samples taken as 10 AM were L; concentrations in samples taken at 10 AM were L; concentrations in samples taken at 1 Asi were significantly higher than in samples taken in the afternoon. There was no significant daily variation in the mean value of the 6 samples taken every day. Concentrations are highest in February (5,900/L) and March (12,000/L), and lowest in November (1,300/L). (See also W91-10612) (Author's abstract) thor's abstract)

DISTRIBUTION OF GIARDIA CYSTS IN WASTEWATER.

Pittsburgh Univ., PA. Graduate School of Public Health.

Heatin.
J. L. Sykora, C. A. Sorber, W. Jakubowski, L. W. Casson, and P. D. Gavaghan.
Water Science and Technology WSTED4, Vol. 24, No. 2, p 187-192, 1991. 1 fig. 4 tab, 13 ref.

Descriptors: \*Giardia, \*Parasites, \*Path of pollutants, \*Protozoa, \*Public health, \*Sludge, \*Wastewater treatment, Centrifugation, Distribution, Effluents, Flotation, Microscopic analysis, Seasonal variation, Sucrose, Wastewater facilities.

The seasonal and geographic distribution of Giardia cysts in wastewater and sludge, and their re-moval by treatment processes, was investigated. Flow-weighted composite samples of raw and

treated wastewaters and sludges were collected monthly for one year from eleven wastewater treatment plants across the United States. Cysts were concentrated by sucrose flotation or by simple centrifugation (direct count) and assayed microscopically. Sucrose flotation counts in raw sewage were extremely variable, producing results ranging from 0.4% to 77.8% of the direct counts. Panging from 0.4% to 77.8% of the direct counts, and using direct counts, the highest geometric mean Giardia cyst concentrations occurred at the California site (3,375 cysts/L), the Florida site (3,087 cysts/L), and the Vermont site (2,040 cysts/L). fornia site (3,375 cysts/L), the Florida site (3,087 cysts/L), and the Vermont site (2,040 cysts/L). The lowest geometric mean Giardia cyst levels were samples from the Pennsylvania site (642 cysts/L), be Tennessee site (762 cysts/L), and the Maryland site (957 cysts/L). Cyst concentrations in raw sewage were highest in late summer, fall, and early winter. Although all raw sewage samples contained cysts, only about one-half of the wastewater treatment plant effluents were positive, with cyst concentrations up to 44 cysts/L. Based on sucrose flotation counts, the concentrations of cysts detected in the sludges ranged from 70 to 30,000 cysts/L. (See also W91-10612) (Author's abstract)

INTERRELATIONS BETWEEN AMOEBAE AND BACTERIA IN THE MOSELLE RIVER, FRANCE.

FRANCE.
Institut Pasteur de Lille, Villeneuve d'Ascq (France). Service des Eaux.
J. M. Delattre, C. Oger, and G. Aprosi.
Water Science and Technology WSTED4, Vol. 24, No. 2, p 193-195, 1991.

Descriptors: \*Amebas, \*Bacteria, \*France, \*Powerplants, \*Temperature effects, \*Water analysis, Chemical analysis, Chlorophyll, Microbiological studies, Moselle River, Pathogens, Rivers, Seasonal variation, Statistical analysis.

The effect of power plant discharges on the presence and abundance of Naegleria, and on other microbiological and chemical parameters, was investigated at 18 sampling stations along the Moselle River (France). Pollution by total bacteria was heavy and uniform. Distribution of thermophilise and the property of the pro was heavy and uniform. Distribution of thermophicia mebae was related statistically (although probably not causally) to fecal pollution. Naegleria distribution appeared to be related to temperature increases, especially downstream of power stations. The dominant species seemed to be N. lovaniensis in early summer and N. australiensis in late summer. Pathogenic N. fowleri were neither frequent nor abundant (maximum 20/100 L); they were found near powerplants, occasionally upstream. Chlorophyll values were uniform (24 mg/cu m). (See also W91-10612) (Doria-PTT) W91-10650

REVIEW OF THE EPIDEMIOLOGY AND DIAGNOSIS OF WATERBORNE VIRAL INFEC-

Institute of Child Health, London (England). Dept. of Virology. W. D. Cubitt.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 197-203, 1991. 1 fig, 46 ref.

Descriptors: \*Epidemiology, \*Human diseases, \*Path of pollutants, \*Public health, \*Viruses, \*Water pollution sources, Chlorination, Clams, Infection, Mollusks, Oysters, Recreation, Reviews, Shellfish, Ships, Swimming, Water conveyance, Water pollution.

A review of advances in the understanding of the A review of advances in the understanding of the significance of viruses as a cause of waterborne infections suggests the importance of problems associated with failures in water supply systems and the hazards of consuming raw or inadequately cooked shellfish. Viruses associated with outbreaks of waterborne infection include Group A and Group B rotaviruses, human caliciviruses, small Group B rotaviruses, numain canciviruses, smail round structured viruses, astroviruses, parvo-like particles, hepatitis A, and poliovirus. Sources of infection have included molluscan shellfish, particularly oysters and clams eaten raw; ice made from fecally polluted water; and water. Between

1976 and 1980, 17 outbreaks of acute nonbacterial gastroenteritis were associated with water. Municipal water supplies were implicated in two out-breaks, semipublic supplies in 7, stored water on cruise ships 2, and recreational swimming water 2. Breakdown of the distribution system is a common cause of outbreaks. Failure to chlorinate swimming pools provides another potential source of infec-tion, and a 3.75 mg/L dose of chlorine sufficient to inactivate polio or human rotavirus has been shown to be insufficient to destroy Norwalk virus. snown to be insurricient to destroy Norwalk Virus. To establish the cause of a waterborne outbreak it is necessary to obtain fecal samples as soon as possible after the onset of symptoms. Acute and convalescent phase samples of serum should be obtained from affected and some asymptomatic individuals. (See also W91-10612) (Doria-PTT) W91-10651

VIROLOGICAL INVESTIGATION OF THE RIVER ELBE.

Medizinische Akademie 'Carl Gustav Carus' Dres-den (German D.R.).

M. Johl, M. L. Kerkmann, U. Kramer, and R. Walter

Water Science and Technology WSTED4, Vol. 24, No. 2, p 205-208, 1991. 3 fig, 1 tab, 2 ref.

Descriptors: \*Elbe River, \*Path of pollutants, \*Pathogens, \*Viruses, \*Water analysis, \*Water pollution sources, Drinking water, Flocculation, Germany, Seasonal variation, Wastewater disposal.

The River Elbe was sampled monthly near Dres-den (Germany), a region where the river, although subject to many domestic and industrial sewage discharges, is used as a source for drinking water. discharges, is used as a source for drinking water.

Samples were concentrated by a two-stage method including aluminum sulfate flocculation. Viral quantification was performed according to the most probably number (MPN) method using F1 cells. Of the samples, 90% were virus positive, with levels ranging from 0.3 MPNCU/L to 52.3 MPNCU/L to 70.00 with an average concentra-MPNCU/L or more, with an average concentra-tion of 7.5 MPNCU/L. This is 12.5 times higher than the level found in the Danube. Local vari-ations of the virus levels were observed. Sampling point 1 (Schmilka) represents the viral contamina-tion coming from Czechoslovakia. Maximum point I (Schmilka) represents the viral contamina-tion coming from Czechoslovakia. Maximum levels were observed at sampling point 3 (Gohlis) just downstream of Dresden, with extensive do-mestic sewage discharges. At this point, virus isola-tion frequency is also highest of all 5 sampling points. Although a well defined seasonal trend in mean viral concentration could not be demonstrated, a trend of increasing virus concentration was observed towards the end of the investigation. (See also W91-10612) (Doria-PTT) W91-10652

VIROLOGICAL QUALITY OF RECREATION-AL WATERS IN THE NETHERLANDS,

Rijksinstituut voor de Volksgezondheid en Milieu-hygiene, Bilthoven (Netherlands). M. van Olphen, H. A. M. de Bruin, A. H. Havelaar, and J. F. Schijven.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 209-212, 1991. 2 fig, 2 tab, 1 ref.

Descriptors: \*Bacteriophage, \*Recreation, \*The Netherlands, \*Viruses, \*Water analysis, \*Water pollution sources, \*Water quality standards, Bacteria, Bioindicators, Enteroviruses, Fecal coliforms, Salmonella, Swimming, Wastewater.

A variety of surface waters in The Netherlands was analyzed for indigenous human enteroviruses in order to evaluate the virological quality of recreational waters for compliance with the mandato-ry European Economic Community (EEC) limit on the absence of enteroviruses in 10-liter samples. The majority of samples that did not exceed the maximum value for fecal coliforms also passed virologically. Eight samples of bathing water (16%) failed to meet the virological requirements of the EEC directive. Only 3 samples out of 51 did not conform to the fecal coliform directive (6%). However, 6 samples that conformed to the fecal coliform standard failed the virus limit. Eleven samples (22%) were positive for salmonellae, of

## Sources Of Pollution—Group 5B

which 8 met the fecal coliform standard. All of the which a first the feed conform standard. All of the enteroviruses isolated were probably from sewage. No enteroviruses could be detected at recreational locations without pollution by untreated sewage or locations without pollution by untreated sewage or effluent discharges from wastewater treatment plants, even though the recreational pressure was high due to warm dry summer weather. The enter-oviruses isolated have yet to be identified. In fresh waters, a better relationship was demonstrated between enteroviruses and FRNA bacteriophages than between enteroviruses and fexal coliforms. Results suggest the utility of these phage as virus models in waters polluted by sewage. (See also W91-10612) (Doria-PTT)

OCCURRENCE OF MALE-SPECIFIC AND SO-MATIC BACTERIOPHAGES IN POLLUTED

MATIC BACTERIOPHAGES IN POLLUTED SOUTH AFRICAN WATERS. Council for Scientific and Industrial Research, Pretoria (South Africa). Div. of Water Technology. R. Kfir, P. Coubrough, and W. O. K. Grabow. Water Science and Technology WSTED4, Vol. 24, No. 2, p 251-254, 1991. 2 fig, 1 tab, 8 ref.

Descriptors: \*Bacteria, \*Bacteriophage, \*Bioindicators, \*South Africa, \*Viruses, \*Water analysis, \*Water quality monitoring, Aquatic environment, Biological treatment, Chlorination, Escherichia coli, Salmonella, Ultraviolet radiation, Wastewater

The occurrence of F' and male-specific coliphages and somatic Salmonella phages in various environ-mental samples from South Africa was studied. mental samples from South Africa was studied. Somatic coliphages outnumbered other bacteriophages in most samples, probably due to the lack of a restriction system in this specific bacterial host. Another explanation for the large number of coliphages obtained is the possible multiplication of the phage in the environmental water samples. Low levels of coliphages were detected using Escherichia coli K12. A marked reduction in malespecific Salmonella phages after biological treatment of the settled sewage can be attributed either ment of the settled sewage can be attributed either to greater sensitivity of these phage to the treatment or to a higher multiplication rate of coli-phages under the same conditions. However, chlorination and dilution in river water resulted in chlorination and dilution in river water resulted in a similar impact on both types of phage with the male-specific phage showing a slightly higher resistance. In dam water, Salmonella phages outnumbered coliphages, possibly due to higher resistance to ultraviolet radiation. In river water, no somatic Salmonella phages were found, and coliphages significantly outnumbered the male-specific Salmonella phages. The low number of male-specific Salmonella phage in river water makes the correlanella phages. The low number of make-specific Salmonella phage in river water makes the correla-tion of these viruses with water difficult. Further comparison studies are needed to verify the corre-lation between male-specific phage and such vi-ruses as rotavirus and hepatitis A. (See also W91-10612) (Doria-PTT) W91-10662

APPLICATION OF MICROBIAL TRACERS IN

APPLICATION OF MICROBIAL TRACERS IN GROUNDWATER STUDIES.
Karlsruhe Univ. (Germany, F.R.). Lehrstuhl fuer Angewandte Geologie.
H. Hotzl, W. Kass, and B. Reichert.
Water Science and Technology WSTED4, Vol. 24, No. 2, p 295-300, 1991. 3 fig, 1 tab, 11 ref.

Descriptors: \*Groundwater movement, \*Groundwater transport, "Microorganisms, "Path of pollutants, "Tracers, Aquifers, Bacteria, Bacteriophage, Filtration, Flow, Karst, Reviews, Sand, Sandstones, Yeasts.

Microbial tracers (bacteria and bacteriophage) were evaluated in several comparative experiments carried out in porous and karst aquifers. Microbial tracers have been used to model subsurface transport of microorganisms, the three main groups used as tracers in groundwater are yeasts, bacteria, and bacteriophage. The most important hydrogeo-logical difference between these groups is the size of the organisms, ranging from about 1,000 nm (yeasts) to about 50 nm (phage). This restricts applicability, especially of the large organisms as general tracers for subsurface flow detection; large

microorganisms can be used only in aquifers with relatively wide openings. This is the case in karst aquifers, where even underground connections of more than 30 km could be marked by microbes. On the other hand, elimination of tracers by filtration in the narrow pores of fine-grained aquifers like sands and sandstones is very efficient and strongly reduces the possibility of migration distance. It is concluded that bacteriophages, because of their concluded that bacteriophages, because of their small size, are the most appropriate microbial tracers. They are completely harmless and applicable under high dilution ratios. By use of different species, they also offer a wide range of tracers for simultaneous experiments. (See also W91-10612) (Doria-PTT) W91-10671

BEHAVIOUR OF PATHOGENIC BACTERIA, PHAGES AND VIRUSES IN GROUNDWATER DURING TRANSPORT AND ADSORPTION.

Tuebingen Univ. (Germany, F.R.). Hygiene Inst. K. Herbold-Paschke, U. Straub, T. Hahn, G.

Teutsch, and K. Botzenhart.
Water Science and Technology WSTED4, Vol.
24, No. 2, p 301-304, 1991. 3 fig, 1 tab, 11 ref.

Descriptors: \*Groundwater transport, \*Path of pollutants, \*Pathogenic bacteria, \*Tracers, \*Viruses, Adsorption, Aquifers, Bacteriophage, Channels, Escherichia coli, Filtration, Germany, Sand, Uranine.

The transport and adsorption behavior of different pathogenic microorganisms was investigated using two kinds of columns filled with quartz sand and two kinds of columns filled with quartz sand and aquifer material. Comparisons were made to uranine tracer. The microorganisms were simian rotavirus SA 11, Escherichia coli, and coliphages T4, MS2, and phi-X174. The breakthrough curve of rotavirus at a filtration rate of 7.8 m/d had a steep main peak with smaller followup peaks; 53% of the viruses injected were adsorbed in the sand. The curve of MS2 phage at a low filtration rate showed a wide distribution, and the peak was delayed by 3 hours. The phage showed a tendency to peak subsequently to or simultaneously to uranine, while the bacteria generally peaked prior to it. More than 50% of the SA 11 rotavirus adsorbed after entering the sand, while only a small percentage of the bacteria and phage adsorbed in the sand. A break-through curve was also generated for E. coli in a inrough curve was also generated for E. Con in a steel channel filled with material from an aquifer near Tubingen (Germany). At a filtration rate of 3.6 m/d, E. coli peaked sharply and dropped sharply after only 2-1/4 hours, while the uranine snarpy arei only 2-1/4 mounts, while the damine tracer remained detectable somewhat longer. Results showed that a change in filtration rate affects the transport behavior of the microorganisms. At reduced filtration rate, microorganisms remained detectable at the column and channel outlets for a much longer time; the percentage of microorganisms adsorbed, however, was no greater than at high filtration rates. (See also W91-10612) (Doria-PTT) W91-10672

FIELD EXPERIMENTS WITH MICROBIOLO-GICAL TRACERS IN A PORE AQUIFER. Tuebingen Univ. (Germany, F.R.). Hygiene Inst. S. Oetzel, W. Kass, T. Hahn, B. Reichert, and K.

Botzenhart.
Water Science and Technology WSTED4, Vol. 24, No. 2, p 305-308, 1991. 4 fig, 1 tab, 5 ref.

Descriptors: \*Bacteria, \*Bacteriophage, \*Groundwater movement, \*Groundwater \*Microorganisms, \*Path of pollutants, Adsorption, Aquifers, Bioindicators, Germany, Serratia, Uranine.

The adsorption and dispersion behavior of Serratia marcescens and the phage phi-X174 were observed in a field near Freiburg (Germany) and compared to that of the tracer uranine. Uranine and phi-X174 to that of the tracer uranine. Uranine and phi-X174 were found to spread with equal velocity 3 h after injection. Serratia and phi-X174 remained concentrated near the injection point, while uranine was distributed to more distant points. The breakthrough curve for uranine shows a relatively flat and uniform drop in concentration. The decrease in concentration of phi-X174 and Serratia was

much more abrupt and irregular. While Serratia was demonstrable to a maximum of only 25 m due to its pronounced adsorption behavior (physicochemical adherence and active adsorption), phi-X174 (physicochemical adsorption but no active adsorption mechanisms) was still detectable to some degree at 100 m. Uranine, which exhibits no sorptive characteristics, was demonstrable in minute quantities even at 400 m. The 6-month persistence of Serratia and phi-X174 under field conditions far exceeded 50 days. This confirms studies showing that the persistence of microorganisms in groundwater aquifers can amount to several months. It is concluded that the transport of a conservative tracer like uranine permits only limited conclusions concerning the possible adsorption and transport characteristics of a microorganisms. On the other hand, the use of microorganisms as indicators of groundwater movement is possible to chemical adherence and active adsorption), phiindicators of groundwater movement is possible to only a limited extent. (See also W91-10612) (Doria-W91-10673

TRANSPORT OF MICROORGANISMS IN THE UNDERGROUND: PROCESSES, EXPERIMENTS AND SIMULATION MODELS.

Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau. G. Teutsch, K. Herbold-Paschke, D. Tougianidou,

T. Hahn, and K. Botzenhart.
Water Science and Technology WSTED4, Vol. 24, No. 2, p 309-314, 1991. 2 fig, 12 ref.

Descriptors: \*Bacteria, \*Bacteriophage, \*Ground-water transport, \*Microorganisms, \*Path of pollut-ants, \*Viruses, Escherichia coli, Flumes, Germany, Gravel, Growth, Model studies, Neckar River, Pseudomonas, Risk assessment, Sand, Streptococcus, Survival.

The major processes governing the persistence and underground transport of viruses and bacteria are reviewed. The simulation of the governing processes is based on the macroscopic mass-conserva-tion equation with the addition of a filter and/or retardation factor and a decay coefficient, representing the natural die-off of the microorganisms. senting the natural die-off of the microorganisms. More advanced concepts try to incorporate growth and decay coefficients together with deposition and declogging factors. None of the reported concepts has yet been validated. Experiments under controlled laboratory conditions are required because of the complexity of natural systems and the pathogenic properties of some of the microorganisms. A laboratory setup is presented in which a great variety of natural conditions can be simulated. This comprises a set of 1-m columns and an 8-m stainless steel flume with 24 sampling ports. The columns are easily filled and conditioned and are therefore used to study the effects of different soil-microorganism combinations under various environmental conditions. Natural underground conditions were simulated in the artificial flume using sand and gravel aquifer material from River sand and gravel aquifer material from River Neckar (Germany) alluvium. Microorganisms studied include the bacteria Escherichia coli, Hafnia alvei, Pseudomonas aeruginosa, Streptococ-cus fecalis; phages T4, MS2, and phi-X174; and poliovirus 1 and rotavirus SA11. The large variety of breakthrough curves and recoveries obtained demonstrate the great uncertainty encountered in microbiological risk assessment. (See also W91-10612) (Doria-PTT)

SPECIES AND GENERA OF ENTEROBACTER-IACEAE IN RIVER NECKAR AND AFTER RIVER BANK FILTRATION AND THEIR RE-SISTANCE PATTERNS TO ANTIBIOTICS AND HEAVY METAL SALTS.

Universitaet des Saarlandes, Saarbruecken (Germany, F.R.). Zentrum fuer Umweltforschung, Angewandte Mikrobiologie und Hygiene.

S. Schneider, and R. Schweisfurth. Water Science and Technology WSTED4, Vol. 24, No. 2, p 315-320, 1991. 6 fig, 3 tab, 8 ref.

Descriptors: \*Bacterial analysis, \*Enterobacter, \*Fate of pollutants, \*Heavy metals, \*Infiltration, \*Neckar River, \*Path of pollutants, \*Stream banks,

#### Group 5B-Sources Of Pollution

Antibiotics, Aquifers, Bacteria, Cadmium, Chromi-um, Cobalt, Copper, Culturing techniques, Genet-ics, Germany, Mercury, Resistance, Tracers,

Water samples (1,000 L) from the River Neckar (Germany), and observation wells, and a drinking water well were assayed for enterobacters by enrichment in a glucose-peptone medium. The isolated strains were tested for susceptibility to mercury, cadmium, copper, zinc, chromium, and cobalt salts and twelve antibiotics. No difference in susceptibilities to heavy metals was found among the different sample types. The resistance frequencies for tetracycline were generally too low in all observation wells and ranged from 12% to 36% too few resistant strains per well. Of examined strains, 100% were resistant to penicillin G, whereas resistances to all other antibiotics tested were within the range found in clinically isolated strains. Increasing distance from the river, linked with increasing detention periods in the aquifer, had no influence on resistance frequencies. As genes coding for resistance to antibiotics as well as to heavy metals are plasmid-linked in enterobacters, the uniformity of data shows the widespread presence of these plasmids. Enterobacters infiltrating the aquifer with slope water were not distinguished from those infiltrating with river water with respect to their susceptibilities to heavy metals. As this may be caused by the low concentrations of heavy metal salts in the river, further investigations should be undertaken to ascertain if heavy metal susceptibility can be used as a tracer for the origin of enterobacters in the aquifer. (See also W91-10612) (Doria-PTT) W91-10675

## BDELLOVIBRIO SP.: A PREDATOR UNDER GROUNDWATER CONDITIONS. A SHORT COMMUNICATION.

Bundesgesundheitsamt, Langen (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene. Z. Filip, P. Schmelz, and R. Smed-Hildman Water Science and Technology WSTED4, Vol. 24, No. 2, p 321-324, 1991. 3 fig, 5 ref.

Descriptors: \*Bacteria. \*Bdellovibrio. \*Biocontrol. Peaciptors: Pacceria, Policioritori, Pacceritoris, Pacceri

The role of Bdellovibrio sp. in affecting the development of Gram-negative bacteria under natural conditions is not yet completely understood. No predatory activity was observed in studies of groundwater samples from a deep pristine aquifer near Langen (Germany). Temperature and pH may play a role as limiting factors. Their ambient values were 10 C and 6.07, respectively. In laboratory experiments using a collection strain of B. bacteriovorus and a wild type from sewage, appreciable numbers of plaques appeared at a minimum temperature of 18 C. The optimum temperature at which more than 100 plaques were counted was 26 C and 30 C. At pH values lower than 6 no plaques c and 30 C. At pri values lower than 6 no plaques were formed, but more than 100 plaques were observed at pH 7, 8, and 9. Different growth stages were identified from the individual plaques using a transmission electron microscope. It is concluded that Bdellovibrio sp. probably does not play a role in the control of populations of Gram-negative bacteris in groundwater having a explaint. bacteria in groundwater having an ambient temperoacteria in groundwater naving an amoient temper-ature of 10 C. However, this presumption needs to be studied, especially in polluted aquifers and in the presence of solid particles from groundwater aquifers; these factors may greatly influence the behavior of both predator and prey. (See also W21-10612) (Doria-PTT) W91-10676

## ATRAZINE HAZARDS TO FISH, WILDLIFE, AND INVERTEBRATES: A SYNOPTIC REVIEW.

Patuxent Wildlife Research Center, Laurel, MD. For primary bibliographic entry see Field 5C. W91-10709

PRELIMINARY DATA SUMMARY FOR THE PHARMACEUTICAL MANUFACTURING POINT SOURCE CATEGORY.

Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards. DC. Office of Water Regulations and Standards. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-126533. Price codes: All in paper copy, A01 in microfiche. Report No. EPA/440/1-89/084, September 1989. 232p, 12 fig. 65 tab, 22 ref. EPA Contract Nos. 68-03-3412, 68-03-6302, 68-03-3366, and 68-03-3339.

Descriptors: \*Industrial wastewater, \*Path of pollutants, \*Pharmaceutical wastes, \*Volatile organic compounds, \*Water pollution effects, Aquatic environment, Aquatic life, Carcinogens, Environmental effects, Public health.

The Industrial Technology Division (ITD) of the US EPA conducted a study of the pharmaceutical manufacturing industry as a result of findings from the Domestic Sewage Study (DSS) and from concern for the potential discharge of toxic and hazardous pollutants from this industry. The study consisted of the following three interrelated but independent undertakings: a technical support study; an economic impact analysis; and an environmental impact analysis. The technical study confirmed that the pharmaceutical manufacturing industry discharges significant quantities of potential in the pharmaceutical manufacturing industry discharges significant quantities of potential in the pharmaceutical manufacturing industry discharges significant quantities of potential in the pharmaceutical manufacturing industry discharges significant quantities of potential in the pharmaceutical manufacturing industry discharges significant quantities of potential in the pharmaceutical manufacturing industry discharges significant quantities of potential in the pharmaceutical manufacturing industry discharges significant quantities of potential in the pharmaceutical manufacturing industry discharges significant quantities of potential industry discharges significant quan industry discharges significant quantities of poten-tially hazardous compounds (especially priority and nonconventional volatile organic compounds and nonconventional volatile organic compounds (VOCs) in raw wastewater. Based on information obtained in the screening and verification sampling program, EPA estimates that 4.7 million lb/yr of priority pollutant VOCs are discharged in the industry's raw wastewater. Sections VIII, X, and XI present the economic impact analysis. The environmental impact study is presented in Section XII. Water quality impacts were projected for 22. ronmental impact study is presented in Section XII. Water quality impacts were projected for 22 direct and 28 indirect discharging plants. Fifteen VOCs were evaluated for direct dischargers, eight of which (all known or suspected carcinogens) were projected to exceed human health criteria in 86% of the stream segments. None of the VOCs evaluated were projected to exceed aquatic life criteria or toxic effect levels. The effects of 28 indirect discharging plants were also evaluated. Twenty-one VOCs were evaluated and six (all known or suspected carcinogens) were projected to exceed human health criteria for carcinogens in 60% of the streams receiving discharges from the publicly owned treatment works (POTWs) to which the plants discharge. No volatile pollutants were projected to exceed aquatic life criteria or toxic effect levels. The impacts by VOCs, as monitored on five streams receiving direct discharges from pharmaceutical plants and on six streams receiving discharges from facilities discharging to POTWs were evaluated. Nine of the 15 pollutants evaluated were detected in four streams receiving direct discharges. Two of the pollutants exceeded human health criteria in three of the streams. Eight of the 21 pollutants evaluated were detected in four streams. Eight of the 21 pollutants evaluated were detected in four streams receiving indirect discharges. Three of the pollutants exceeded human health criteria in three of the streams. (Lantz-PTT) W91-10710

#### SUPERFUND RECORD OF DECISION: COM-MENCEMENT BAY/S. TACOMA, WA.

DC. Office of Emergency and Remedial Response. For primary bibliographic entry see Field 5G. W91-10711

# TREATABILITY OF HAZARDOUS CHEMI-CALS IN SOILS; VOLATILE AND SEMIVOLA-TILE ORGANICS,

Oak Ridge National Lab., TN. Environmental Sciences Div.

B. T. Walton, M. S. Hendricks, T. A. Anderson,

B. T. Walton, M. S. Hendricks, T. A. Anderson, and S. S. Talmage.

Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-016892.

Price codes: Al3 in paper copy, AOI in microfiche. Environmental Sciences Division Publication No. 3283, Report No. ORNL-6451, July 1989. 286p, 9 fig. 21 tab, 49 ref, 5 append. EPA Interagency Agreement No. DW8993143-01-0.

Descriptors: \*Cleanup, \*Fate of pollutants, \*Hazardous wastes, \*Path of pollutants, \*Site remediates ation, \*Soil contamination, \*Volatile organic comation, "Soil contamination, "Volatile organic com-pounds, Acrylonitrile, Benzenes, Bioaccumulation, Biodegradation, Chloroform, Dichlorobutene, Furans, Naphthalenes, Organic compounds, Phys-icochemical analysis, Sorption, Toluene, Trichloropropane

Selected hazardous organics, primarily volatiles and semivolatiles, were evaluated for toxicity to soil microorganisms, sorption to soil, degradation, and potential for bioaccumulation in terrestrial plants and animals. The chemicals included in the study were acrylonitrile, furan, methyl ethyl ketone, tetrahydrofuran, benzene, toluene, 1,2dichloroethane, p-xylene, chlorobenzene, chloro-form, nitrobenzene, trans-1,4-dichloroethane, cis-1,4-dichloro-2-butene, 1,2-dichlorobenzene, 1,2,3-trichloropropane, carbon tetrachloride, 2-chloron-aphthalene, benzidine, ethylene dibromide, 3,3-di-methylbenzidine, 1,2,4,5-tetrachlorobenzene, 3,3dichlorobenzidine, methylpyrilene, and hexachloro-benzene. Sorption partition coefficiencies based on oenzene. Sorption partition certificate osaet on soil organic matter were high for 2-chloronaphthalene (4.65) and hexachlorobenzene (4.59); were moderate for toluene (2.19), p-xylene (2.60), chlorobenzene (2.33), cis-1,4-dichloro-2-butene (2.33), 1,2-dichlorobenzene (2.99), carbon tetrachloride (2.06), nitrobenzene (1.99), 1,2,3-trichloropropane (1.92) and 1,2,4,5-tetrachlorobenzene (2.79); and (1.92) and 1,2,4,5-tetrachlorobenzene (2.79); and low for the remaining compounds. Those chemicals with the longest half-lives in soil were nitrobenzene, hexachlorobenzene, 1,2,4,5-tetrachlorobenzene, and 2-chloronaphthalene, whereas those rapidly nonrecoverable by solvent extraction were p-xylene, chlorobenzene, chloroform, and cis-1,4-dichlorobenzene. Evaluation of all 24 chemicals dichlorobenzene. Evaluation of all 24 chemicals for bioaccumulation potential based on physicochemical properties implicated only 1,2,4,5-tetrachlorobenzene and hexachlorobenzene tot be of high concern. Linear correlations for physicochemical parameters with chemical effects on soil respiration and degradation parameters were poor for the complete data set. However, they were quite good for a subset of benzene and its chloro, and alkyl-derivatives. (Lantz-PTT) W91-10712

# SUPERFUND RECORD OF DECISION: CHEMTRONICS (AMENDMENT), NC.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. For primary bibliographic entry see Field 5G.

# PRELIMINARY DATA SUMMARY FOR THE PAINT FORMULATING POINT SOURCE CAT-

Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards. For primary bibliographic entry see Field 5C.

#### SUPERFUND RECORD OF DECISION: IBM (SAN JOSE), CA.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. For primary bibliographic entry see Field 5G.

# USING OIL SPILL DISPERSANTS ON THE

National Research Council, Washington, DC. Commission on Engineering and Technical Systems. For primary bibliographic entry see Field 5G.

W91-10716

# SUPERFUND RECORD OF DECISION: DELA-WARE SAND AND GRAVEL, DE,

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. For primary bibliographic entry see Field 5G.

### Sources Of Pollution—Group 5B

SUPERFUND RECORD OF DECISION:
PESSES CHEMICAL, TX.
Environmental Protection Agency, Washington,
DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W91-10718

SUPERFUND RECORD OF DECISION: IRON HORSE PARK, MA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. For primary bibliographic entry see Field 3G. W91-10719

SUPERFUND RECORD OF DECISION: SOUTH VALLEY (PL-83), NM.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. For primary bibliographic entry see Field 5G. W91-10721

ACID-BASE STATUS OF PENNSYLVANIA STREAMS: RESULTS FROM THE NATIONAL STREAM SURVEY.

SIREAM SURVEY,
Virginia Univ., Charlottesville.
K. N. Eshleman, P. R. Kaufmann, and A. T.
Herlihy.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB90-134313.
Price codes: A03 in paper copy, A01 in microfiche.
Report No. EPA/600/D-89/224, 1989. 10p, 1 fig, 1
tab, 11 ref.

Descriptors: \*Acid rain, \*Acid streams, \*Acidifica-tion, \*Hydrogen ion concentration, \*Path of pol-lutants, \*Pennsylvania, Acid neutralizing capacity, Acidity, Water pollution effects, Water quality.

The National Stream Survey, (NSS) conducted by the EPA in the spring of 1986, sampled 82 stream reaches within the state of Pennsylvania, represent-ing a target population of 9900 stream reaches that are potentially sensitive to acidification. After ex-cluding streams that were acidified by acid mine drainage, an estimated 9% of the reaches were chronically acidic during spring baseflow at the upstream end, while less than 1% of the stream reaches were acidic at their downstream end. Comparable percentages of streams with an acid neutralizing capacity (ANC) between 0 and 50 microeq/L were also identified, with the majority microeq/L were also identified, with the majority of these streams found in the Appalachian Plateau. Almost all of the chronically acidic streams in the state are small (<20 sq km), upland headwater streams draining watersheds that are more than 95% forested. Population estimates of the percentages of streams with an ANC < 200 microeq/L. agree favorably with an Arc V agree favorably with estimates by the Pennsylvania Fish Commission for managed and unmanaged stream sections of the state. (Author's abstract) W91-10726

COMPREHENSIVE COOLING WATER STUDY, FINAL REPORT, VOLUME I: SUM-MARY OF ENVIRONMENTAL EFFECTS. Savannah River Lab., Aiken, SC. Environmental

Sciences Div.

Sciences Div.

N. V. Halverson, J. B. Gladden, M. W. Lower, H.
E. Mackey, and W. L. Specht.

Available from the National Technical Information
Service, Springfield, VA. 22161, as DE88-010377.

Price codes: A05 in paper copy, A01 in microfiche.
Report No. DP-1739-1, October 1987. 68p, 14 fig.,
7 tab, 60 ref. DOE Contract DE-AC09-6SR00001.

Descriptors: \*Cooling water, \*Path of pollutants, \*Savannah River Plant, \*Thermal pollution, Beaver Dam Creek, Flow pattern, Four Mile Creek, Nuclear powerplants, Nuclear reactors, Par Pond, Steel Creek, Three Runs Creek.

The Savannah River Plant (SRP) was acquired by the US Government in the early 1950s to construct a facility for production of nuclear materials for a facility for production of nuclear materials to the United States weapons program. Most major nuclear material production related facilities were completed and operational by 1954. These facilities included a fuel fabrication facility, five production reactors, two chemical separations facilities to

remove and purify the required radioisotopes, a remove and purify the required radioisotopes, a heavy water moderator production facility, and a coal-fired electricity/steam generation facility. Ad-ministrative and support facilities were also con-structed. Initially, all five production reactors, the coal-fired power plant, and the heavy water facili-ty were cooled in a once-through mode using water pumped through three intake structures lo-cated on the Savannah River. Both the volume of the water pumped and the temperature of the discharged effluent tended to increase through the 1950s as reactor power levels were increased. At 1950s as reactor power levels were increased. At peak power levels, SRP reactors discharge approximately 11 cu m/sec of cooling water at 70 C to 75 C. Four of the five major stream systems on io 75 C. Four of the five major stream systems on the SRP have received reactor effluents. Beaver Dam Creek, a lesser drainage system, has received cooling water releases of a smaller magnitude than those creeks associated with reactor operations (Four Mile Creek, Pen Branch, Steel Creek, Lower Three Runs Creek). Only Upper Three Runs Creek has not received cooling water effluent. Four SRP streams that have received cooling water releases drain into the SRP Savannah River swamp, a 3,800 ha riverine swamp forest bordering the Savannah River and contained within the SRP boundaries. Flows from Upper Three Runs and boundaries. Flows from Upper Three Runs and Lower Three Runs Creeks discharge directly into the Savannah River, but these streams have relatively little swamp forest development near the creek mouths. (Lantz-PTT) W91-10729

PERMITTING NONPOINT SOURCES: PROGRAMS, PROVISIONS, PROBLEMS AND PO-

GRAMS, FROVISIONS, FROBLEMS AND FO-TENTIAL. Harvard School of Public Health, Boston, MA. For primary bibliographic entry see Field 5G. W91-10730

REMEDIAL INVESTIGATION OF THE HIGH EXPLOSIVES BURN PIT FACILITY, BUILD-ING 829 COMPLEX, LAWRENCE LIVER-MORE NATIONAL LABORATORY SITE 300. Lawrence Livermore National Lab., CA. Environ-

Lawrence Livermore National Lab., C.A. Environ-mental Restoration Div. C. P. Webster-Scholten, and N. B. Crow. Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-017741. Price codes: A04 in paper copy, A01 in microfiche. Report No. UCID--21692, August 1989.

Descriptors: \*Explosives, \*Groundwater pollution, \*Lawrence Livermore National Laboratory, \*Path of pollutants, \*Water pollution sources, Geohydrology, Infiltration, Monitoring wells, Piezometers, Trichloroethene, Volatile organic compounds.

To assess any impact on the environment resulting from operations at the High Explosives (HE) Burn Pits at Lawrence Livermore National Laboratory (LLNL) Site 300, the soil, rock, and groundwater beneath the burn pit facility, were evaluated. Between November 16, 1986, and January 12, 1987, eight exploratory holes were drilled; one was converted to a monitor well, and another was converted to a piezometer. Seven holes were drilled, geologically logged, and sampled to determine the concentration and extent of substances that may have infiltrated to the subsurface from the burn pits. The eighth hole was completed as a monitor well but was not sampled, and no detailed log was prepared. Electric logging was performed in one exploratory hole to further evaluate the geologic conditions. The evaluation of the HE Burn Pit facility showed that levels of HE compounds in facility showed that levels of HE compounds in the underlying soil and rocks are generally low, with concentrations higher at the surface, decreas-ing with depth. Some aberrations have been re-ported; e.g., the increase in HE concentrations between 95 and 100 ft in hole 829-03 in a weath-rerd-appearing zone with abundant fractures (pos-sibly resulting from earth movement). With the excention of one surficial sample in one exploratoexception of one surficial sample in one exploratory hole, all explosives concentrations in soils are significantly below the designated levels. Volatile organic compounds (VOCs) in soil and rocks have organic compounds (VOCs) in soil and closs have been reported only beneath pits 2 and 3 and at low concentrations. Concentrations of trichloroethene (TCE) up to 5.4 microgm/L in water from well W-829-08 are slightly above the State Action

Level. Further analyses of water samples will provide information with which a trend analysis may be made, but it currently appears that the concen-trations of TCE in groundwater may be decreas-ing. Because the burn pits are regulated under the authority of the Resource Conservation and Re-covery Act (RCRA), a RCRA closure is required for the HE Burn Pit Facility. (Lantz-PTT) W91-10731

STATUS OF GROUND WATER IN THE 1100

Westinghouse Hanford Co., Richland, WA.

A. G. Law.

A. U. Law. Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-016119. Price codes: A03 in paper copy, A01 in microfiche. Report No. WHC-MR-0034, July 1989. 25p. DOE Contract DE-AC08-87RL10930.

Descriptors: \*Data collections, \*Groundwater quality, \*Hanford Site, \*Monitoring, \*Washington, Drinking water, Maximum contaminant level, Monitoring wells, Water quality, Water quality

The groundwater in the 1100 Area of the Hanford Site, Richland, WA is monitored as a precautionary measure since the City of Richland's recharge and well field site is downgradient from the US Department of Energy (DOE) past practice, non-radioactive disposal sites. It is believed that there is insufficient desires from the US radioactive disposal sites. It is onleved that there is insufficient driving force to move contaminants down to the water table, and modeling suggests that the well field is operated in such a manner that movement into the well field is unlikely. Monitoring of five wells installed in late 1988 is being conducted to provide additional assurance on the safety of the groundwater for use by residents of Richland. The three wells near the well field are sampled monthly and analyses are performed for several constituents deemed to be indicative of potential contaminants from DOE facilities. All several constituents deemed to be indicative of potential contaminants from DOE facilities. All five wells are sampled quarterly with analyses conducted for a lengthy list of constituents. Results of the analyses indicate that the groundwater meets drinking water standards. The results of the monitoring to date comprise the majority of this document. The first section is a map of the 1100 Area showing the location of the five new wells. Section 2 is a listing of the analytical results from the monthly sampling of the three wells near the well field. Section 3 is a listing of all results for routine monitoring of the wells since the work was initiated in November 1988. This listing contains the detection limit and the drinking water standard or maximum contaminant level, where appropriate, of each constituent. In reviewing the data, it was observed that the concentration of nitrate, although one-half the drinking water standard, was higher in Well 699-S43-E12 near the Purchasing building vis-a-vis the other wells. The reason for apparent anomaly is to be investigated as more data become available. (Lantz-PTT)

PRELIMINARY DATA SUMMARY FOR THE HOSPITALS POINT SOURCE CATEGORY.

Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.

Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-126459. Price codes: A05 in paper copy, A01 in microfiche. Report No. EPA 440/1-89/060-n, September 1989. 76p, 2 fig, 14 tab, 15 ref, 2 append.

Descriptors: \*Data collections, \*Hospitals, \*Water pollution sources, Hazardous wastes, Pollutant identification, Waste management.

This is one of a series of Preliminary Data Summa-ries prepared by the Office of Water Regulations and Standards of the US EPA. The Summaries and Standards of the US EPA. The Summaries contain engineering, economic and environmental data that pertain to questions about whether the industrial facilities in various industries discharge pollutants in their wastewaters, and whether the EPA should pursue regulations to control such discharges. This document summarizes the most

#### Group 5B-Sources Of Pollution

current information available regarding the dis-charge of wastewater and solid wastes containing priority and hazardous non-priority pollutants by hospitals. The objectives of this document are to: (1) provide a technical basis for determining (1) provide a technical basis for determining whether additional national regulations should be developed pursuant too the Clean Water Act (CWA), and (2) make available preliminary information regarding the discharge of priority and hazardous non-priority pollutants by the hospital industry. The hospital industry profile is presented in Section 2.0. Section 3.0 characterizes hospital wastewater in terms of the presence of priority and hazardous non-priority pollutants and provides ad-ditional information on these and other pollutant discharges from hospitals. Various waste management practices and control and treatment technologies are described in Section 4.0. Environmental and economic impact analyses were not performed as part of this study and, consequently no such analyses are discussed in this document. (Lantz-PTT) W91-10738

PRELIMINARY DATA SUMMARY FOR THE PESTICIDE CHEMICALS POINT SOURCE CATEGORY.

ironmental Protection Agency, Washington, Office of Water Regulations and Standards.

DC. Office of Water Regulations and Standards. T. Fielding, and J. Goodwin.

Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-126426.

Price codes: A03 in paper copy, A01 in microfice. Report No. EPA/440/1-89/060-e, August 1989.

Descriptors: \*Data collections, \*Pesticides, \*Surveys, \*Water pollution sources, Industrial production, Industrial wastes.

This is one of a series of Preliminary Data Summa-ries prepared by the Office of Water Regulations and Standards of the US EPA. The Summaries and standards of the US EA. The summaries contain engineering, economic and environmental data that pertain to questions about whether the industrial facilities in various industries discharge pollutants in their wastewaters, and whether the pollutants in their wastewaters, and wnemer me EPA should pursue regulations to control such discharges. This Preliminary Data Summary for the Pesticide Chemicals Point Source category consists of: (1) early findings from the EPA Census of Pesticides; and (2) EPA estimates of pollutant of Pesticides; and (2) EPA estimates of pollutant discharges (loads) for pesticide manufacturers and pesticide formulators and packagers (PFPs). The EPA designed the 'Pesticide Manufacturing Facility Census' for 1986 to collect information on production, wastewater generation and treatment, and financial data from pesticide manufacturing plants. The Census requested information relating to the production of approximately 300 pesticide activing redients (Als), known as 'in-scope Als.' Two hundred forty-two copies of the technical portion of the questionnaire were distributed to the pesticide chemicals industry in the Summer of 1988. Based upon the returned questionnaires: 92 are manufacturers of in-scope Als; but not manufacturers of out-of-scope Als, but not manufacturers of in-scope Als; 80 are Pesticide Formulators/Packagers (PFPs), but not manufacturers; 34 are neither ers (PFPs), but not manufacturers; 34 are neither anufacturers nor PFPs; and, 26 are closed. The 92 manufacturers produce 160 in-scope Als. Of those 92 plants: 35 are direct dischargers; 36 are indirect dischargers; and, 21 are no-discharge plants. (Lantz-PTT) W91-10739

HEALTH RISK ASSESSMENT OF TOLUENE IN CALIFORNIA DRINKING WATER. California Univ., Davis. Dept. of Environmental

Toxicology. For primary bibliographic entry see Field 5C. W91-10741

ARCHIMEDES IIA EXPERIMENT ON OIL SLICK DETECTION OVER THE NORTH SEA--APRIL 1988-MEASUREMENT RESULTS OB-TAINED BY THE E-SAR SYSTEM OF THE AEROSPACE RESEARCH ESTAB-LISHMENT.

che Forschungs- und Versuchsanstalt fuer

Luft- und Raumfahrt e.V., Oberpfaffenhofen (Germany, F.R.). R. Horn, and A. Moreira.

A. Riorit, and A. Moreira. Available from the National Technical Information Service, Springfield, VA. 22161, as N89-28942. Price codes: A03 in paper copy, A01 in microfiche. Report No. DFVLR-Mitt.89-08, March 1989. 43p, 27 fig. 11 ref.

\*ARCHIMEDES experiment, \*Aerial photography, \*Data acquisition, \*North Sea, \*Oil spills, \*Path of pollutants, Histograms, Oil pollution, Radar, Radiometry, Remote sensing.

The ARCHIMEDES IIa was an experiment on oil slick detection conducted over the North Sea. Data was obtained using the experimental airborne synthetic aperture radar (SAR) system-E-SAR. The system was part of the research program at the Institute for Radio Frequency Technology of the German Aerospace Research Establishment. During the experiment carried out on 21. Amont. During the experiment carried out on 21 April 1988, the system was operated in L-band at 1.29 GHz, and results were obtained concerning an oil of 5 cu m of crude oil. The data showed that slick of 5 cu m of crude oil. The data showed that a SAR is suitable for oil spill detection on the sea surface, and demonstrated the capability of the L-band E-SAR system, even with a very low transmitted peak power of 50 W, at altitudes of up to 1000 M above ground. It was also shown to be possible to discriminate between the oil and sea surface. If there had been simultaneous radiometer measurements, a thickness distribution within the oil slick could also have been derived. Finally, it was found that the data could distinguish between was found that the that could distinguish between different types of oil spills or biogenic films, by evaluating the intensity histograms of the SAR image data. (Lantz-PTT) W91-10742

URBAN STORM-INDUCED DISCHARGE IM-

Environmental Protection Agency, Edison, NJ. Storm and Combined Sewer Technology Branch. R. Field, and R. E. Pitt.

Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-112566. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/600/D-89/130, 1989. 7p, 26 ref.

Descriptors: \*Land use, \*Path of pollutants, \*Storm runoff, \*Urban runoff, \*Water pollution edfects, \*Water pollution sources, Aquatic life, Bellevue, California, Coyote Creek, Fishkill, Sediment transport, Toxicity, Urbanization, Washington, Water chemistry.

The effects of storm-induced discharges on receiving water aquatic organisms or other beneficial uses is very site specific. Different land developmeet practices may create substantially different runoff flows. Different rain patterns cause different particulate washoff, transport and dilution condi-tions. Local attitudes also define specific beneficial uses and desired controls. There is also a wide variety of water transuses and desired controls. There is also a wide variety of water types receiving urban runoff, and these waters all have watersheds that are urbanized to various degrees. Therefore, it is not surprising that urban runoff effects are also quite variable and site specific. Attempts to identify urban runoff problems using available data have not been con-clusive because of differences in the sampling pro-cedures and the common practice of prodling data cedures and the common practice of pooling data from various sites, or conditions. It is, therefore, necessary to carefully design comprehensive, long-term studies to investigate urban runoff problems on a site specific basis. Sediment transport, deposition, and chemistry play key roles in urban receivations. on a site specific oasis. Sediment transport, deposi-tion, and chemistry play key roles in urban receiv-ing waters and need additional research. Receiving water aquatic biological conditions, especially compared to unaffected receiving waters, should be studied to support laboratory bioassays and literature information. The two West Coast studies summarized in this paper both found significant aquatic life beneficial use impairments in urban creeks, but the possible causes were quite different. The Coyote Creek, California study found major accumulations of toxic sediments in the urban accumulations of toxic secuments in the urban reaches of the creek, while the Bellevue, Washing-ton study found very little toxic material in the sediments. The Bellevue urban creek had a very large carrying capacity for sediment and high flow

rates which apparently flushed the toxic sediments through the creek and into Lake Washington. Fish kills were observed in Bellevue, but they were associated with illegal storm drain discharges during dry weather. The long-term aquatic life effects of urban runoff are probably more important than short-term effects associated with specific versits. The long-term effects are probably related. tant than short-term effects associated with specific venents. The long-term effects are probably related to the deposition and resuspension of toxic sediments, or the inability of the aquatic organisms to adjust to repeated exposures to high concentrations of toxic materials or high flow rates. Long-term effects may only be expressed at great distances downstream from discharge locations, or in accumulating areas (such as lakes). (Lantz-PTT) W91-10745

SOIL VAPOR SURVEY AT THE LLNL SITE 300 GENERAL SERVICES AREA, ADJACENT PORTIONS OF THE CONNOLLY AND GALLO 6 AREA.

Weiss Associates, Oakland, CA. S. Vonder Haar, J. Pavletich, W. McIlvride, and M. Taffet.

Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-011646. Price codes: A04 in paper copy, A01 in microfiche. Report No. UCRL—21183, April 4, 1989. 63p, 15 fig, 2 tab, 17 ref, append.

Descriptors: \*Groundwater pollution, \*Lawrence Livermore National Laboratory, \*Path of pollut-ants, \*Soil contamination, \*Soil vapor, \*Trichlor-oethylene, \*Water pollution sources, Dichloroeth-ene, Diffusion, Monitoring, Monitoring wells, Te-tanh Lorecthylene, Trichloroeth-gue trachloroethylene. Trichloroethane

During October through December, 1988, a soil vapor survey was conducted at the Lawrence Livermore National Laboratory Site 300 General Services Area (GSA), adjacent portions of the Connolly and Gallo Ranches, and at the Site 300 Landfill Pit 6 area. The purpose of the investigation was to aid in identifying the sources and the extent of trichloroethylene (TCE) previously found in groundwater and soil at, or near, these sites. Using a soil vapor probe, samples were collected at 133 locations from depths of 2 to 15 ft below the surface. TCE concentrations detected in below the surface. TCE concentrations detected in the soil vapor ranged from a high of 628 parts per million (ppm) to a low of not detected (ND) at < 0.001 to 0.005 ppm. The highest concentration was found next to monitor well W-7F, near a decommissioned drywell (sump) at the southern boundary of the GSA. Several locations exhibited ND of the higher concentrations of TCE (> 30 ppm) detected in the soil vapor at five sample points are attributable to TCE sources in unsaturated soil. The lower concentrations (< 5 ppm) may reflect either low concentration TCE sources in unsaturated soil and/or diffusion of TCE upward from contaminated groundwater. (Lantz-PTT) W91-10747

SUPERFUND RECORD OF DECISION. MID-STATE DISPOSAL LANDFILL, WI.

Environmental Protection Agency, Washington, For primary bibliographic entry see Field 5G. W91-10749

CONFIRMATORY CHEMICAL ANALYSES AND SOLID PHASE BIOASSAYS ON SEDIMENT FROM THE COLUMBIA RIVER ESTU-ARY AT TONGUE POINT, OREGON. Battelle Pacific Northwest Labs., Sequim, WA. Marine Research Lab.

Marine Research Lab.
J. S. Young, M. E. Barrows, J. Q. Word, V. I.
Cullinan, and C. W. Apts.
Available from the National Technical Information
Service, Springfield, VA 22161, as DE89-005679.
Price codes: A05 in paper copy, A01 in microfiche.
Report No. PNL-6792, December 1988. 75p, 5 fig,

#### Sources Of Pollution—Group 5B

47 tab, 16 ref, 4 append. DOE Contract DE-AC06-76RLO 1830.

Descriptors: \*Columbia River, \*Dredging effects, \*Dredging wastes, \*Environmental impact, \*Oregon, \*Water pollution sources, Amphipods, Chemical analysis, DDT, Dredging, Estuaries, Path of pollutants, Pollutant identification, Polychaetes, Sediment contamination, Water resources

The state of Oregon plans to develop a former ship supply and storage site near Tongue Point, Oregon, for commercial shipping, requiring dredging of the adjacent waterway to the Columbia River 40-foot channel to admit commercial vessels. Bioassays were conducted which would provide technical data for an evaluation of the potential environmental impact of ocean disposal of the dredged material. These tests revealed elevated concentrations of some contaminants in the Tongue Point sediment. All solid-phase bioassays (conducted on clams, polychaetes and amphipods) (conducted on clams, polychaetes and amphipods) < 10% mortality in both reference and control sediments, which makes all tests valid. The bioas-says under static and flow-through conditions resulted in no statistically significant difference in survival among treatments for three of the four test species. Only one test (R. abronius, static) had species. Only one test (R. abronus, static) had survival in test sediments significantly different from controls. In that test > 10% of the amphipods died in the test sediment; however, survival ranged from 60 to 95% among the replicates of the two composites. This indicates a possible patchiness to the sediment toxicity even though the composites appeared homogeneous A class disposal of posites appeared homogeneous. Actual disposal of Tongue Point sediment in the ocean will probably result in dilution of contaminants by flowing sea-water during and after its descent to the sea floor, water during an after its descent or the sea froot, thereby minimizing acutely toxic effects. A significant enhancement of 4,4'-DDD, a degradation product of DDT, was seen in the issues of clams at an average concentration of 8.0 micrograms/Kg (wet weight). Allowable limits for interstate commerce are 5000 micrograms/Kg (wet weight), or a factor of 625-fold the concentration measured in the clams. No other chemicals were bioaccumulated. (Lantz-PTT) W91-10753

EFFECTS OF LAND-USE BUFFER SIZE ON SPEARMAN'S PARTIAL CORRELATIONS OF LAND USE AND SHALLOW GROUND-WATER

Geological Survey, Trenton, NJ. For primary bibliographic entry see Field 4C. W91-10761

GROUND-WATER FLOW AND SOLUTE MOVEMENT TO DRAIN LATERALS, WEST-ERN SAN JOAQUIN VALLEY, CALIFORNIA. I. GEOCHEMICAL ASSESSMENT.

Geological Survey, Sacramento, CA. S. J. Deverel, and J. L. Fio. Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Feder-al Center, Denver, Co. 80225-0425. Open-File Report 90-136, 1990. 23p, 15 fig, 25 ref.

Descriptors: \*California, \*Geochemistry, \*Geohydrology, \*Groundwater movement, \*Path of pollutants, \*San Joaquin Valley, \*Selenium, \*Solute transport, Drainage, Drainage systems, Flow profiles, Groundwater irrigation, Groundwater recharge, Mixing.

A study was undertaken to quantitatively evaluate the hydrologic processes affecting the chemical and isotopic composition of drain lateral water from an agricultural field in the western San Joaquin Valley, California. Results from chemical and isotopic analysis of the samples, and analysis of hydraulic head data and drain lateral flow data, elucidate the process of mixing of deep and shallow groundwater entering the drain laterals. The deep groundwater was subject to partial evaporation prior to drainage system installation and has been displaced downward (at depths > 6 meters) been displaced downward (at depths > 6 meters) in the groundwater system. This groundwater is flowing toward the drain laterals. The percentage of deep, isotopically enriched groundwater enter-

ing the drain laterals varies with time and between drain laterals. The percentage of the total drain lateral flow, which is deep groundwater flow, is about 30% for the shallow drain lateral (1.8 meters about 30% for the shallow drain lateral (1.8 meters below land surface) and 60% for the deep drain lateral (2.7 meters below land surface). During irrigation, these percentages decrease to 0 and 30% for the shallow and deep drain laterals. Selenium loads in the drain laterals vary with time and between drain laterals. The selenium load for the shallow drain lateral (8 kg) during 1 year is 21% of the load for the deep drain lateral (332 kg) because it collects less deep, high selenium groundwater and does not flow continuously. Although selenium concentrations in the drain lateral water decreased during irrigation, selenium loads inselenium concentrations in the drain lateral water decreased during irrigation, selenium loads increased substantially during a preplant irrigation because of increased flow into the drain laterals. The selenium loads during 8 days of irrigation represented a substantial percentage (25% for the shallow drain lateral and 11% for the deep drain lateral) of the total selenium load for 1 year. (See also W91-10769) (Author's abstract)

GROUND-WATER FLOW AND SOLUTE MOVEMENT TO DRAIN LATERALS, WEST-ERN SAN JOAQUIN VALLEY, CALIFORNIA. II. QUANTITATIVE HYDROLOGIC ASSESSMENT.

JACATA
J. L. Fio, and S. J. Deverel.
Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, Co 80225-0425. Open-File Report 90-137, 1990. 15p, 10 fig, 2 tab, 21 ref.

Descriptors: \*Drainage, \*Geohydrology, \*Groundwater movement, \*Path of pollutants, \*San Joaquin Valley, \*Selenium, \*Solute transport, California, Groundwater irrigation, Groundwater recharge, Hydrologic models, Irrigation, Models tudies, Simulation analysis, Surface-groundwater

Groundwater flow modeling was used for the estimation of groundwater flow paths and travel times to quantitatively assess the hydrologic processes to quantitatively assess the hydrologic processes affecting groundwater and solute movement to drain laterals. Modeling results were used to calculate the depth distribution of groundwater flowing into drain laterals at 1.8 meters (drain lateral 1) and 2.7 meters (drain lateral 2) below the land surface. These simulations indicated that under nonitrigations of the desired of the control of the These simulations indicated that under nonirrigated conditions, about 89% of the flow in drain lateral 2 was from groundwater originating at depths > 6 m below the land surface. Deep groundwater was found to have higher selenium concentrations than shallow groundwater. Simulation of irrigated conditions indicates that as recharge increases, the proportion of deep groundwater entering the drain laterals decreases. Groundwater flow modeling also was used to estimate selenium loads in drain laterals for varying drain lateral flow rates. Simulated loads were in general agreement with measured loads and increase with increasing drain lateral flow. Simulations further indicated that groundwater containing high selenium concentrations probably will ing high selenium concentrations probably will continue to enter drain lateral 2 for more than 8 years. (See also W91-10768) (Author's abstract) W91-10768

LAND USE, WATER USE, STREAMFLOW CHARACTERISTICS, AND WATER-QUALITY CHARACTERISTICS OF THE CHARLOTTE HARBOR INFLOW AREA, FLORIDA.

For primary bibliographic entry see Field 4C. W91-10771

PERMEABILITY OF SOILS WITH ORGANIC

Arizona Univ., Tucson. Dept. of Civil Engineering and Engineering Mechanics. M. Budhu, R. F. Giese, G. Campbell, and L.

Baumgrass. Canadian Geotechnical Journal CGJOAH, Vol. 28, No. 1, p 140-147, February 1991. 5 fig, 2 tab, 16

Descriptors: \*Leachates, \*Oil pollution, \*Organic compounds, \*Path of pollutants, \*Permeability, \*Soil properties, \*Soil types, Clays, Correlation analysis, Dielectric constant, Fluid flow, Illite, Kaolinite, Montmorillonite, Permeameters, Physical properties, Soil mechanics

Permeability measurements, using a consolido-meter, were made for kaolinite, montmorillonite, and a clay-rich soil (the Lockport clay) with a variety of organic liquids and water as permeants. These data, along with selected values from the literature, were used to evaluate several theories literature, were used to evaluate several theories that have been proposed as explanations for the general observation that permeabilities of clay soils with organic fluids as the permeants are higher than with water as the permeant. Of the several obvious differences in physical properties between water and organic liquids (e.g., dielectric constant, viscosity, dipole moment, specific gravity, and surface tension), only the dielectric constant provided a consistent correlation with the permeabilities a consistent correlation with the permeabilities a consistent contention with the permeabilities for the or-ganic chemicals used can be predicted using the measured permeability for the soil with water as the permeant and the dielectric constant of the organic by way of an exponential equation. For mixtures of acetone-water and methanol-water, the permeabilities did not vary linearly with the com-position. Rather, the permeabilities remained close to values for pure water until approximately 70% (by volume) of the fluid was organic. (Author's abstract) W91-10783

IMPACT OF RECHARGE THROUGH RESIDUAL OIL UPON SAMPLING OF UNDERLYING GROUND WATER.

Auburn Univ., AL. Dept. of Civil Engineering. W. R. Wise, C. C. Chang, R. A. Klopp, and P. B.

Ground Water Monitoring Review GWMRDU, Vol. 11, No. 2, p 93-100, Spring 1991. 11 fig, 14 ref.

Descriptors: "Gasoline, "Groundwater pollution, "Groundwater recharge, "Path of pollutants, "Solute transport, Benzene, Correlation analysis, Infiltration, Oil spills, Organic compounds, Rainfall, Sampling, Soil gases, Toluene, Unconfined aquifers, Xylenes.

At an aviation gasoline spill site in Traverse City, Michigan, historical records indicate a positive correlation between significant rainfall events and increased concentrations of slightly soluble organic compounds in the monitoring wells of the site. To investigate the recharge effect on groundwater quality due to infiltrating water percolating past residual oil and into the saturated zone, an in situ residual oil and into the saturated zone, an in situ infiltration experiment was performed at the site. Sampling cones were set at various depths below a circular test area, 13 feet (4 meters) in diameter. Rainfall was simulated by sprinkling the test area at a rate sufficiently low to prevent runoff. The response of the soil-gas and groundwater quality were monitored during the recharge and drainage periods, which resulted from the sprinkling. Infiltrated water was determined to have transported organic constituents of the residual oil, specifically benzene, toluene, ethylbenzene, and ortho-xylene (BTEX), into the groundwater beneath the water table, elevating the aqueous concentrations of these constituents in the saturated zone. Soil-gas concenidual oil and into the saturated zone, an in situ table, elevating the aqueous concentrations of these constituents in the saturated zone. Soil-gas concentrations of the organic compounds in the unsaturated zone increased with depth and time after the commencement of infiltration. Reaeration of the unconfined aquifer via the infiltrated water was observed. Water quality measurements were directly coupled to recharge events for the sandy type of aquifer with an overlying oil phase. (Author's abstract) W01-10703 W91-10793

FIELD SAMPLING OF RESIDUAL AVIATION GASOLINE IN SANDY SOIL.

Massachusetts Univ., Amherst. Dept. of Civil En-For primary bibliographic entry see Field 5A. W91-10795

## Group 5B-Sources Of Pollution

UTILITY OF MULTIPLE-COMPLETION MONITORING WELLS FOR DESCRIBING A SOLVENT PLUME.

Oak Ridge National Lab., TN. Environmental Sciences Div.

For primary bibliographic entry see Field 7A. W91-10800

OCCURRENCE OF APPENDIX IX ORGANIC CONSTITUENTS IN DISPOSAL SITE CONSTITUENTS IN DISPO GROUND WATER, Lockheed-EMSCO, Las Vegas, NV.

Ground Water Monitoring Review GWMRDU, Vol. 11, No. 2, p 157-164, Spring 1991. 1 fig, 2 tab, 9 ref. U. S. Environmental Protection Agency Contract Nos. 68-03-3050 and 68-03-3245.

Descriptors: \*Groundwater pollution, \*Hazardous wastes, "Monitoring, "Organic pollutants, "Pollutant identification, "Waste disposal, Cost analysis, Data interpretation, Databases, Pesticides, Sampling, Volatile organic compounds.

Monitoring data from 479 disposal site investiga-Monitoring data from 4/2 disposal site in conditions were used to provide an initial estimate of the occurrence and distribution of 208 Appendix IX organic constituents in groundwater. The most occurrence and distribution of 208 Appendix IX organic constituents in groundwater. The most prevalent class of contaminants were the volatile organic compounds, which accounted for 84 percent of all the detectable events in the composite data set involving Appendix IX organic constituents. The abundance of the remaining subsets of Appendix IX organic constituents decreased in the following order: base/neutral compounds (8.6 percent), acid extractable compounds (3.5 percent), pesticides (3.0 percent), Resource Conservation and Recovery Act (RCRA) pesticides (0.6 percent), and non-priority pollutants (0.25 percent). The current regulatory requirement to monitor for Appendix IX organic constituents is approximately Appendix IX organic constituents is approximately Appendix IX organic constituents is approximately four times more expensive than monitoring for conventional priority pollutants (volatile, base/neutral, acid extractable, and pesticide compounds). Because the non-priority pollutant compounds account for an estimated 76 percent of the Appendix IX analytical costs but only 0.25 percent of the detectable events in disposal site groundwater, it has been recommended that this class of compounds be deleted from reuting monitoring compounds be deleted from routine monitoring programs. A scaling back of the current require ment to the conventional priority pollutants would still target more than 99 percent of the Appendix IX organic constituent occurrences in groundwat-er and would result in substantial analytical cost savings. (Author's abstract) W91-10801

DETERMINATION OF EFFECTIVE DIFFU-SION COEFFICIENTS FOR GASEOUS AND DISSOLVED ORGANIC SUBSTANCES IN SOIL MATERIAL USING A STOPPED ELUTION' METHOD WITH HPLC AND GC. Bayreuth Univ. (Germany, F.R.). Chair of Ecolog-ical Chemistry and Geochemistry. For primary bibliographic entry see Field 7B. W91-10802

MODELLING WATER AND SOLUTE TRANS-PORT IN MACROPOROUS SOIL. I. MODEL DESCRIPTION AND SENSITIVITY ANALYSIS. Sveriges Lantbruksuniversitet, Uppsala. Dept. of Soil Sciences.

N. J. Jarvis, P. E. Jansson, P. E. Dik, and I.

Journal of Soil Science JSSCAH, Vol. 42, No. 1, p 59-70, March 1991. 5 fig, 1 tab, 31 ref.

Descriptors: \*Data interpretation, \*Model studies, Peats in the second of the sec

It has been recognized that macropores allow a analysis of the second second

arrival of the solute at any given depth occurring at much less than one pore volume displaced. A detailed mechanistic model of water movement and transport of non-reactive solute in a macroporous soil was developed which considers water and ous soil was developed which considers water and solute transport in a soil profile divided into layers, which may be of varying thickness, with an upper boundary at the soil surface and a lower boundary at a specified depth. In the two-dimensional version of the model, the total soil porosity in each layer is divided into interacting flow regions (i.e., page 2002-2014). macropores and micropores), each of which is characterized into a water content and a flux. In preliminary model applications, a sensitivity analysis was performed for water discharges and solute breakthrough curves under steady rain inputs. A comparison made between the output from the one-domain and the two-domain models illustrated the conditions under which a second flow domain may need to be considered. The simulations suggested that decisions concerning the need to con-sider a second flow domain certainly depend on the scale of the soil structure, and are influenced by initial and boundary conditions. (Korn-PTT) (See also W91-10804)

MODELLING WATER AND SOLUTE TRANSPORT IN MACROPOROUS SOIL. II. CHLORIDE BREAKTHROUGH UNDER NON-

Sveriges Lantbruksuniversitet, Uppsala. Dept. of Soil Sciences.

For primary bibliographic entry see Field 2G. W91-10804

BIOCHEMICAL AND HISTOCHEMICAL OB-SERVATIONS ON EFFECTS OF LOW-LEVEL METAL LOAD (LEAD, CADMIUM) IN DIF FERENT ORGAN SYSTEMS OF THE FRESH-WATER CRAYFISH, ASTACUS ASTACUS L, (CRUSTACEA: DECAPODA),

raerztliche Hochschule Hannover (Germany, F.R.). Inst. fuer Zoologie. W. Meyer, M. Kretschmer, A. Hoffmann, and G.

Harisch. Ecotoxicology and Environmental Safety EESADV, Vol. 21, No. 2, p 137-156, April 1991. 8 fig, 85 ref.

Descriptors: \*Bioaccumulation, \*Crayfish, \*Heavy metals, \*Path of pollutants, \*Toxicity, \*Toxicology, \*Water pollution effects, Cadmium, Crustaceans, Enzymes, Hazard assessment, Invertebrates, Lead, Tissue analysis.

The biological impact of heavy metals in aquatic systems has become a major concern in recent years. One of the most interesting aspects, in particular in view of long-term effects, is the influence of low-level heavy metal concentrations on different ecological systems. The effects of low-level lead (20 micrograms/L) exposure on the structure and function of different organ systems of Astacus astacus were estimated by several biochemical and histochemical methods. The animals were incubatnistocnemical methods. The animals were incubated during 10 weeks (max.) at a temperature of 10 C and a normal diurnal rhythm. Lead accumulated in high amounts exercically in the discounting the second like in the second lin and a normal diurnal rhythm. Lead accumulated in high amounts especially in the digestive gland, carapace, and gills, whereas the hindgut and musculature exhibited very low lead levels. Cadmium accumulated particularly in the digestive gland and gills. Lead and cadmium levels were definitely lower in the digestive gland, gills, and carapace of animals incubated in water containing a double, i.e., lead and cadmium load, than in animals kept in water containing only one of these heavy metals. Histochemically, both metals could be visualized in a typical distribution within the tissues, such as the carapace, digestive gland, or gills. After several weeks of poisoning, all organs, especially the digestive gland, showed severe structural damage. The activities of oxidative enzymes in the digestive gland and gills were significantly lowered after 2 weeks of incubation. Enzyme histochemical evaluation demonstrated changes of reaction intensities uation demonstrated changes of reaction intensities within the organs as compared to the controls.

GSH S-transferase activities and GSH contents were also distinctly decreased following lead and/or cadmium intoxication. The histochemical demonstration of SH and S-S groups exhibited a stronger staining reaction after 10 weeks of expo-sure, especially in digestive gland and gills. (Au-thor's abstract)

STUDIES ON THE ENVIRONMENTAL PER-SISTENCE OF S-31183 (PYRIPROXYFEN): AD-SORPTION ONTO ORGANIC MATTER AND POTENTIAL FOR LEACHING THROUGH

California Univ., Parlier. Mosquito Control Research Lab.

C. H. Schaefer, E. F. Dupras, and F. S. Mulligar Ecotoxicology and Environmental Safety EESADV, Vol. 21, No. 2, p 207-214, April 1991. 1 fig, 3 tab, 11 ref. USDA Cooperative Agreement No. 82-CRSR-2-1010.

Descriptors: \*Leaching, \*Nonpoint pollution sources, \*Path of pollutants, \*Pesticides, \*Soil analysis, \*Soil contamination, \*Wastewater lagoons, Analytical methods, Mosquitoes, Organic matter, Pyriproxyfen, Soil columns, Soil types

Analytical methods were developed to allow the extraction and analysis of S-31183 (pyriproxyfen), 2-(1-methyl-2-(4-phenoxypethoxy) pyridine, in organic matter from animal wastewater lagoons. Analysis of water and organic debris from lagoons. Analysis of water and organic deons from a treated lagoon showed that the active ingredient readily adsorbed into organic matter. S-31183 per-sisted on organic matter for over a 2-month period, during which time the concentration decayed at an exponential rate. In leaching trials with four different soil types, over 50% of the active ingredient applied remained in the upper 6 cm of a 30 cm soil column; there was no indication of a rapid potential for downward migration. The use of S-31183 that for downward migration. The use of 8-31185 for treating wastewater lagoons at doses which are effective for mosquito control did not result in any apparent problems of environmental incompatibility. (Author's abstract) W91-10831

PULSED FIELD ELECTROPHORESIS OF GENOMIC RESTRICTION FRAGMENTS FOR THE DETECTION OF NOSOCOMIAL LE-GIONELLA PNEUMOPHILA IN HOSPITAL WATER SUPPLIES.

Wuerzburg Univ. (Germany, F.R.). Inst. fuer Genetik und Mikrobiologie.
For primary bibliographic entry see Field 5A.
W91-10836

SEASONAL VARIATIONS OF ALIPHATIC HYDROCARBONS IN SARDINA PILCHARDUS (WALB.) (TELEOSTEI: CLUPEIDAE) TISSUES, Bologna Univ. (Italy). Ist. di Biochimica

G. P. Serrazanetti, L. S. Conte, P. Cortesi, C.

Totti, and R. Viviani.

Marine Chemistry MRCHBD, Vol. 32, No. 1, p 918, January 1991. 1 fig, 3 tab, 21 ref.

Descriptors: \*Adriatic Sea, \*Aliphatic hydrocarbons, \*Bioaccumulation, \*Fish, \*Italy, \*Path of pollutants, Seasonal variation, Tissue analysis, Water pollution effects.

Aliphatic hydrocarbons present in the tissues of samples of Sardina pilchardus, a plankton-ivorous fish, from the Adriatic Sea were analyzed to determine the presence, origin (biogenic or fossil) and metabolic fate of the hydrocarbons which reach metabolic face of the hydrocarbons which reach the fish from the environment. Samples were ob-tained from off the coast of Emilia-Romagna (Italy) during the months of December, April, June and September. The highest amounts of total hydrocarbons were detected in June and Septemer, the lowest in April, and intermediate levels in December. Among tissues, the highest concentra-tions were found in mesenteric fat. Predominant hydrocarbons were n-C-17 (saturated) and isoprenoid squalene (unsaturated). The uniformity of the qualitative distribution of these compounds in the qualitative distribution of these compounds in the various tissues analyzed showed that these hydrocarbons undergo limited metabolic change. Based on the presence of n-C-17 olefins with 17 and 19 carbon atoms and heneicosahexaene, it is assumed that these hydrocarbons isolated from the tissues of

#### Sources Of Pollution-Group 5B

S. pichardus are of recent biological and not of fossil origin. However, it must be emphasized that this fish is pelagic and is able to leave a heavily polluted zone. The composition of the isolated hydrocarbons excludes the possibility in the samples analyzed of petroleum contamination by human activities along the Adriatic coastline. (Medina-PTT) W91-10839

FLUXES AND TRANSPORT OF ANTHROPO-GENIC AND NATURAL POLYCYCLIC ARO-MATIC HYDROCARBONS IN THE WESTERN MEDITERRANEAN SEA.

Paris-6 Univ. (France). Lab. de Physique et Chimie

Marines.

E. Lipiatou, and A. Saliot.
Marine Chemistry MRCHBD, Vol. 32, No. 1, p
51-71, January 1991. 3 fig. 5 tab, 60 ref. Commission of the European Communities Fourth Environment R and D Program, Contract EV 4V-0111-F
and CNRS grant GRECO Interactions Continuent/Opens

Descriptors: \*Gulf of Lions, \*Marine pollution, \*Path of pollutants, \*Polycyclic aromatic hydrocarbons, \*Rhone River, \*Sediment analysis, \*Water pollution sources, Air pollution, Fate of pollutants, France, Gas chromatography, Liquid chromatography, Mass spectrometry, Pollutant identification, Sediment contaminants.

Surface sediments were collected in the Gulf of Lions and in the Rhone delta (France) and analyzed for composition of polycyclic aromatic hydrocarbons (PAH). After isolation of lipids, the drocaroons (FAM). After isolation of pipus, the hydrocarbons were separated into fractions by high-performance liquid chromatography (HPLC) and fractions were analyzed by gas chromatography (GC) and gas chromatography/mass spectrometry (GC/MS). Annual PAH fluxes were calculated for the northwestern Mediterranean basin. The fluxes of open-sea sediments varied from 164 micrograms/sq m/yr for a station located far from the coast and influenced by atmospheric deposition, up to 1420 micrograms/sq m/yr for stations directly influenced by the Rhone river input, whereas stations located in the Rhone delta were whereas stations located in the Rhone delta were characterized by higher fluxes, up to 12,250 micrograms/sq m/yr. PAH concentrations decreased significantly with distance from the river mouth. Detailed analysis of PAH revealed the presence of anthropogenic compounds, pyrolytic and petrogenic, and naturally derived compounds. The distance of the presence of the pre genic, and naturally derived compounds in the tribution and ratios of specific compounds of PAH are analyzed as a function of morphological and sedimentological features to evaluate and characterize the respective importance of atmospheric terize the respective importance of atmospheric and Rhone-derived river inputs. Pyrolytic inputs from anthropogenic combustion processes were predominant at all stations. Compounds of natural origin were quantified, such as retene and related abietic acid precursors, and pentacyclic triterpenes derived from alpha and beta amyrins. Anthropogenic PAH fluxes, determined for an open-sea sediment corresponding to the end of the ninetaenth. genic PAH Illuxes, determined for an open-sea sedi-ment corresponding to the end of the nineteenth century (approximately 100 years ago), were three to four times less than the current flux; however, the retene flux was equal to or higher than that of today. (Author's abstract) W91-10841

DISPERSAL DYNAMICS OF GROUNDWATER BACTERIA. Lund Univ. (Sweden). Dept. of Ecological Chem-

istry. R. Lindqvist, and G. Bengtsson.
Microbial Ecology MCBEBU, Vol. 21, No. 1, p
49-72, 1991. 8 fig, 5 tab, 62 ref, append.

Descriptors: \*Aquifers, \*Dispersal, \*Groundwater pollution, \*Mathematical models, \*Model studies, \*Path of pollutants, \*Population dynamics, \*Soil bacteria, Hydrodynamics, Nutrient concentrations, Soil columns, Suspended solids.

Variations in partitioning as a consequence of the nutrient conditions was analyzed to use this infor-mation in mathematical models to predict the dis-persal rate of bacteria in aquifers. Two different models were used to describe dispersal: an advec-

tive-disvective-sorptive model with a first order kinetic sink term to account for irreversible cell reactions, such as death and sorption; and a twosite reaction model, in which the retardation was assumed to be determined by two types of sites, one characterized by instantaneous equilibrium sorption reactions and the other by kinetic nonequilibrium reactions. Water-saturated sand columns were used as continuous-flow groundwater microcosms to test the models under different nu-trient regimes. Two strains of indigenous groundwater bacteria were isolated from aquifer material. Both experimental data and model variables showed that dispersal of bacteria was a dynamic showed that dispersal of bacteria was a dynamic nonequilibrium process, possibly shaped by two subpopulations, one strongly, even irreversibly, adsorbing to the solid particles, and one with very slow adsorption kinetics. Cell surface hydrophobicity was about 8 times higher in groundwater than in eutrophic lake water. The partition coefficient varied between 12.6 in the groundwater and 6.4 in the lake water, indicating the prime importance of hydrophobic binding for attachment in low nutrient conditions. The partitioning was also sensitive to the hydrodynamics of the system and the oxygen supply, as demonstrated in a continuous flow cell. About 45% of the population was associated with sand particles with continuous flow of pure groundwater and as little as 20% in lake water. However, more than 50% of the bacteria in the aqueous phase were associated with suspended the aqueous phase were associated with suspended material of less than 60 micrometers in diameter. This association may enhance dispersal by size exclusion of the colloidal material in the interstitial spaces. (Medina-PTT) W91-10843

RHINE RIFT VALLEY GROUNDWATER-RIVER INTERACTIONS: EVOLUTION OF THEIR SUSCEPTIBILITY TO POLLUTION.

Laboratoire de Botanique et Cryptogamie, URA 95 CNRS, Centre d'Etudes et de Reserche Biographiques, PIREN Eau Alsace, Faculte de Pharma-cie BP 24, 67401 Illkirch, France.

R. Carbiener, and M. Tremolieres.

Regulated Rivers Research & Management RRRMEP, Vol. 5, No. 5, p 375-389, November/ December 1990. 4 fig. 10 tab, 43 ref. Support from PIREN Eau Alsace (CNRS No. 80 279, region Alsace) and by Sandoz foundation (Convention Sandoz-CNRS no 80.9044-509642, convention ULP no 88/903/060).

Descriptors: \*Alluvial aquifers, \*Flood control, \*Flooding, \*Groundwater pollution, \*Path of pollutants, \*Regulated flow, \*Rhine River, \*Surfaceroundwater relations, Bioaccumulation, Chlorinated hydrocarbons, Fish, Organophosphorus, Re-

Results of research on the ecology of the Rhine and its tributaries undertaken between 1970 and 1990 were reviewed and compared with relevant data in the literature on the ecology of canalized rivers within the Rhine system and other large rivers in western Europe. The exchange processes between the Rhine river and the alluvial aquifer were analyzed in the upper part of the Rift Valley (upstream of Strasbourg). Hydraulic works, and the consequent suppression of flooding, along the Alsace Rhine floodplain greatly modified these processes. The transfer of persistent toxic micropollutants (organochlorine compounds, mercury), and non-persistent pollutants (organophosphorus compounds: Sandoz spill) from the Rhine to the groundwater-fed streams was shown by pollutant data in the literature on the ecology of canalized groundwater-fed streams was shown by pollutant bioaccumulation in fish (particularly eel) and eubioaccumulation in fish (particularly eel) and eutrophication of these streams near the canalized river. Comparison of the hydrological functioning of the two main river floodplains (the Rhine and its tributary, the III, in the Alsace Rhine plain) showed two completely different exchange processes: in the canalized Rhine, the groundwater is affected by direct transfer of pollutants through the channel bed. In the river III, where the floodplain is extensively flooded each year, the soil-root system of the alluvial forest and meadow very effectively purify the floodwaters transferred to the groundwater. (Medina-PTT)

OFF-RIVER STORAGES AS SOURCES AND SINKS FOR ENVIRONMENTAL CONTAMI-

Ok Tedi Mining Ltd., Port Moresby (Papua New

Guinea).

R. J. Higgins.

Regulated Rivers Research & Management RRRMEP, Vol. 5, No. 5, p 401-412, November/ December 1990. 6 fig, 5 tab, 18 ref.

Descriptors: \*Model studies, \*Off-river storage, \*Papua New Guinea, \*Path of pollutants, \*Water storage, Flood control, Flow discharge, Mine wastes, Sediment transport, Streamflow, Water

An off-river storage is one for which filling, storage, and draining behavior is governed by a water-course which does not pass through the storage area. Off-river storages accept water from their adjacent stream, often when streamflow is high, and may return water, to the stream when stream. and may return water to the stream when stream flow is low. In addition, they usually have a water catchment of their own, independent of the main stream, which may contribute a significant propor-tion of inflow to the storage in total or on some occasion. Off-river storages have many uses in-cluding water supply and flood mitigation, and can also be a significant resource in their own right. In also be a significant resource in their own fight. In the same manner that off-river storages receive, hold, and subsequently discharge water flow, so contaminants contained in the water column may be received, held, and released. However, the be received, need, and released. However, the timescale of contaminant retention and release may be quite different from that applying to water flows. Also physical, chemical and biological proc-esses in the storage may alter the nature of the contaminants, such that released materials have different environmental implications from those input. A conceptual model of the dynamics of these processes in an off-river storage has allowed identification of factors which must be considered in assessing each case, and provides a possible common approach to the analysis of different cases. The model was used to assess the possible cases. The model was used to assess the possible influence on off-stream storages of sediments in transport and the metal contained in these sediments which enter the Fly River of Papua New Guinea as a result of mining operations. (Medina-W91-10851

ASSIMILATION OF METALS IN MARINE CO-PEPODS AND ITS BIOGEOCHEMICAL IM-PLICATIONS,

State Univ. of New York at Stony Brook. Marine Sciences Research Center. For primary bibliographic entry see Field 2L.

BEHAVIOR OF HEAVY METALS IN A MUD FLAT OF THE SCHELDT ESTUARY, BEL-GIUM.

Vrije Univ., Brussels (Belgium). Dienst Analytische Scheikunde en Geochemie.

S. Panutrakul, and W. Baeyens. Marine Pollution Bulletin MPNBAZ, Vol. 22, No. 3, p 128-134, March 1991. 4 fig, 3 tab, 19 ref.

Descriptors: \*Belgium, \*Heavy metals, \*Intertidal areas, \*Mud flats, \*Path of pollutants, \*Sediment contamination, \*Sediment-water interfaces, Cadmium, Interstitial water, Iron, Lead, Manganese, Organic matter, Physicochemical properties, Scheldt Estuary, Sulfur bacteria.

The Ballasplaat intertidal mud flat in the Sch The Ballispians intertical much fair in the Scheldi estuary (Belgium) has been polluted by Cd and Pb and also high amounts of organic matter as a result of suspended matter deposition. The degree of pollution is, however, not uniform over the mud flat due to varying physicochemical conditions (esentially variable redox profiles). Measurements of the redox profile and the metal concentrations in the pore water, the total sediment and the fraction <63 microns combined with sequential extraction results and enrichment factors can explain the be-havior of Cd, Pb, Fe and Mn in the sediments. In a strong anoxic sediment, where sulfate reducing bacteria are active, the heavy metals are trapped as

#### Group 5B-Sources Of Pollution

poorly soluble metal complexes while in an oxic or suboxic sediment metals tend to be redissolved due to the oxidation of organic matter and the reduc-tion of particulate Fe and Mn oxyhydroxides. The transportation of heavy metals across the sediment water interface is very much dependent on the physicochemical conditions of the sediment. (Author's abstract) W91-10872

EFFECT OF THREE PRIMARY TREATMENT SEWAGE OUTFALLS ON METAL CONCEN-TRATIONS IN THE FISH CHEILODACTYLUS

TRATIONS IN THE FISH CHEILODACTYLUS FUSCUS COLLECTED ALONG THE COAST OF SYDNEY, AUSTRALIA. Metropolitan Water, Sewerage and Drainage Board, Sydney (Australia). C. McLean, A. G. Miskiewicz, and E. A. Roberts. Marine Pollution Bulletin MPNBAZ, Vol. 22, No. 3, p 134-140, March 1991. 2 fig, 2 tab, 35 ref.

Descriptors: \*Australia. \*Bioaccumulation. \*Coast-Descriptors: Australia, Bioaccumulation, \*Const-al waters, \*Fish populations, \*Heavy metals, \*Path of pollutants, \*Wastewater pollution, \*Water pol-lution sources, Arsenic, Cadmium, Copper, Lead, Mercury, Nickel, Selenium, Sydney, Tissue analy-Wastewater outfall, Zinc

Samples of muscle tissue from red morwong Cheilodactylus fuscus (Pisces: Cheilodactylidae) collodactylus fuscus (Pisces: Chellodactyludae) col-lected at 24 sites along the coast near Sydney, Australia, were analyzed for total concentrations of Hg, As, Se, Zn, Cd, Pb, Ni and Cu. The sites were equally spaced around each of the three major ocean disposal sewage treatment plants (STP) in Sydney located at North Head, Bondi and Malabar. The mean concentrations of Hg, As, and Maasoar. The mean concentrations of fig. 85, and Zn were highest in fish caught off Sydney Harbor and Malabar STP. The proportion of fish in which Cd was detected was also highest off Sydney Harbor and south of Malabar STP. Aver-Sygney runroor and south of maladar 31°. Average Se concentrations decreased from north to south with peak concentrations at each STP. Many individual values of Cu, Pb, and Ni were near or below the detection limits and no notable trends were observed for these metals. Hg was the only metal whose overall mean concentration exceeded the National Health and Medical Research Council Maximum Residue Limit. (Author's abstract) W91-10873

COEFFICIENT OF POLLUTION (P): THE SOUTHERN CALIFORNIA SHELF AND SOME

OCEAN OUTFALLS. California State Univ., Long Beach. Dept. of Biol-

D. Maurer, G. Robertson, and I. Haydock. Marine Pollution Bulletin MPNBAZ, Vol. 22, No. 3, p 141-148, March 1991. 8 fig, 1 tab, 7 ref.

Descriptors: \*California, \*Coefficient of pollution, \*Marine pollution, \*Path of pollutants, \*Pollution index, \*Wastewater outfall, \*Water pollution effects, Coastal waters.

The coefficient of pollution (p) was developed to measure the extent of contamination in coastal waters of the Mediterranean. This measure incorporates abiotic variables (granulometry and depth) that strongly influence fundamental biotic parameters (species composition, number of species, number of individuals) in a single index. Implicit in p is that excessive amounts of organic and inorganic waste modify the benthic fauna. These modifications may alter species composition, the order of abundance of species, reduce the number of species. abundance of species, reduce the number of species, and sometimes the number of individuals. cies, and sometimes the number of individuals. This coefficient was applied to the southern California shelf including three major ocean outfalls (Whites Point, Orange County, San Diego City). Values of p from the shelf were considerably lower than those reported for portions of the Gulf of Saronikos for which the coefficient was originally developed. Corrections to an earlier application of p to Whites Point did not change major conclusions, but did change the magnitude of values, reducing them in this case. Within the California shelf there were regional differences in p at various outfalls. There was a significant reduction of p at Whites Point between 1973-84. Values of p at the Orange County outfall were generally

lower than at the other outfalls. The development of an integrated (abiotic-biotic) measure of pollution incorporating granulometry and depth and basic community parameters (number of species and number of individuals) is highly desirable. (Author's abstract) W91-10874

PATELLA VULGATA, MYTILUS MINIMUS AND HYALE PREVOSTI AS BIOINDICATORS FOR PB AND SE ENRICHMENT IN ALEXAN-DRIA COASTAL WATERS.

Alexandria Univ. (Egypt). Dept. of Oceanography. For primary bibliographic entry see Field 5A. W91-10875

TAR BALLS ON IBENO-OKPOSO BEACH OF SOUTH-EAST NIGERIA.
Calabar Univ. (Nigeria). Inst. of Oceanography.

F. E. Asuquo.

Marine Pollution Bulletin MPNBAZ, Vol. 22, No.

3, p 150-151, March 1991. 2 fig, 1 tab, 5 ref.

Descriptors: \*Beach contamination, \*Marine pollu-tion, \*Nigeria, \*Offshore platforms, \*Oil pollution, \*Oil spills, \*Path of pollutants, \*Tar balls, \*Water pollution, Seasonal variation, Wave action.

A study was undertaken to quantitatively assess the standing stock of tar and to investigate the prevalent oceanographic factors influencing the level of tar on the Ibeno-Okposo beach of southlevel of tar on the Ibeno-Okposo beach of southeast Nigeria. The highest monthly amount of tar collected during a survey of 30 stations along a 25 km beach front in 1988 was 1.39 g/sq m/m in January; the lowest was 0.04 g/sq m/m in October. Generally, high levels of tar were recorded between January and May (>0.30 g/sq m/m). Except in May, a low amount of tar was recorded during the rainy season (June-October, <0.2 g/sq m/m). Tar balls ranged from <10 mm to 8.5 cm in diameter. The amount of tar obtained during the diameter. The amount of tar obtained during the period was relatively low, with the maximum value 63% and 25% of the maximum values in 1985 and 1986, respectively. This reduction is attained to the period was relatively low. and 1960, respectively. This reduction is at-tributed to the absence of reported major oil spill incidents, suggesting that only relatively small amounts of oil entered the marine environment from minor spills. With the presence of large offshore oil platforms adjoining the beach studied, high levels of tar balls would have been expected to be deposited due to the combined effects of spilled oil from offshore production and other sources. The low tar content reported in this study is partly attributed to the short beach front caused by the existence of transient beach scarps and by the existence of transpirate beach scarps and partly to the influence of dominating spilling breaker waves associated with flat beach profiles. The scarps impede the transportation of tar to the supralittoral, thereby impeding the amount of tar left by waves after each swash action. (Sand-PTT) W91-10876

BIOACCUMULATION, ELIMINATION AND METABOLISM OF TRIPHENYLTIN CHLO-RIDE BY EARLY LIFE STAGES OF MINNOWS

PHOXINUS PHOXINUS, Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Due-bendorf (Switzerland).

bendorf (Switzerianu). K. Fent, R. Lovas, and J. Hunn. Naturwissenschaften NATWAY, Vol. 78, No. 3, p 125-127, March 1991. 2 fig, 1 tab, 9 ref.

Descriptors: \*Antifoulants, \*Bioaccumulation, \*Fish physiology, \*Fungicides, \*Metabolism, \*Minnows, \*Organotin compounds, \*Path of pollutants, Biological magnification, Embryonic growth stage, Larval growth stage, Tissue analysis, Triphenyltin chloride.

The accumulation, depuration, and metabolism of triphenyltin (TPT) chloride in embryos and/or yolk fry of the minnow Phoxinus phoxinus were investigated. In the first series of experiments, ferinvestigated. In the first series of experiments, fertilized eggs were exposed for 192 h to determine the uptake during both embryonic and larval stages. In the second set of experiments, freshly hatched larvae were exposed for 144 h to determine uptake, and for 192 h to determine uptake

and subsequent elimination. TPT and its metabolites diphenyltin and monophenyltin were analyzed by capillary gas chromatography with flame photometric detection. The experiments showed a rapid uptake of TPT from water, while an elimination was absent during the 96-h observation period. There was a linear relationship between the external concentration of TPT and body weight. Whole-body tissue concentrations of TPT did not reach between which indicates that the bioaccuse. reach plateaus, which indicates that the bioaccu-mulation is even higher in larvae than determined in these experiments. Thus, the calculated biocon-centration factors for TPT (concentration in wet centration factors for 1P1 (concentration in wet tissue/initial concentration in water) being 530 in the embryonic/larval exposure after 192 h, and 457 and 930 after 96 h and 144 h, respectively, in the larval exposure, underestimate the real bioconcen-tration factors. The TPT elimination from larval tration factors. The LFT elimination from farvitissue was extremely slow, and the metabolites remained very low in tissue during uptake and elimination, suggesting an absence or a very slow catabolism of TPT. This behavior of TPT--the high potential for bioaccumulation, rapid uptake, and low elimination and metabolism--is similar to other organic compounds that have a known high bioaccumulation potential. (Sand-PTT) W91-10877

MERCURY BODY BURDEN AND OTOLITH CHARACTERISTICS OF BLUEFIN TUNA FROM THE NORTHWEST MEDITERRANEAN (BALEARIC SEA).

Universitat de les Illes Balears, Palma de Mallorca (Spain). Inst. d'Estudis Avancats.
For primary bibliographic entry see Field 2L. W91-10881

SORPTION PHENOMENA IN SUBSURFACE SYSTEMS: CONCEPTS, MODELS, AND EFFECTS ON CONTAMINANT FATE AND TRANSPORT.

IRANSFORI.
Michigan Univ., Ann Arbor. Dept. of Environmental and Water Resources Engineering.
W. J. Weber, P. M. McGinley, and L. E. Katz.
Water Research WATRAG, Vol. 25, No. 5, p 499528, May 1991. 26 fig, 4 tab, 59 ref.

Descriptors: \*Fate of pollutants, \*Groundwater pollution, \*Model studies, \*Path of pollutants, \*Sorption, \*Subsurface systems, Adsorption kinetics, Literature review, Mathematical models, Physicochemical properties, Theoretical analysis.

The behavior, transport and ultimate fate of con-taminants in subsurface environments may be af-fected significantly by their participation in sorp-tion reactions and related phenomena. The degree to which the resulting effects can be quantified and predicted depends upon the extent to which cer-tain fundamental aspects of sorption are under-stood, and upon the accuracy with which these phenomena can be characterized and modeled in complex subsurface systems. This review covers current levels of understanding of the reactions current levels of understanding of the reactions and processes comprising sorption phenomena, and the forms and utilities of different models used to describe them. Emphasis is placed on concept development, on the translation of these concepts and models into functional models for characterizing sorption rates and equilibria, and on the application of these concepts and models for explaining contaminant behavior in subsurface systems. Examples are provided to illustrate the impacts of sorption phenomena on contaminant transport. (Author's abstract) W91-10882

HYDROCARBONS IN URBAN RUNOFF: THEIR CONTRIBUTION TO THE WASTEWATERS.

Universidad Politecnica de Madrid (Spain). Escuela Tecnica Superior de Ingenieros de Caminos, Canales y Puertos

M. T. Bomboi, and A. Hernandez. Water Research WATRAG, Vol. 25, No. 5, p 557-565, May 1991. 4 fig, 2 tab, 34 ref.

Descriptors: \*Highway effects, \*Hydrocarbons, \*Path of pollutants, \*Polycyclic aromatic hydro-

#### Sources Of Pollution-Group 5B

carbons, \*Storm wastewater, \*Urban runoff, Aliphatic hydrocarbons, Automobile exhaust, Carcinogens, Petroleum products, Seasonal variation,

A hydrocarbon characterization analysis was applied to extractable organic matter from Madrid runoff. The effects of traffic densities as well as seasonal and meteorological influences were considered. The main contribution is the exhausts from vehicles, which are distinguished by the presence of petroleum residues in the form of aliphatic and aromatic hydrocarbons. Polycyclic aromatic hydrocarbons. drocarbons with carcinogenic potency ever also identified from incomplete combustion products in automobile exhausts. Natural hydrocarbons derived from higher vascular plants are present on residential and landscaped areas in high levels. W91-10885

DELAY IN LAKE RECOVERY CAUSED BY INTERNAL LOADING.

Environment Institute, JRC Ispra, 21020 Ispra, For primary bibliographic entry see Field 2H. W91-10886 Varese, Italy.

VOLATILE ORGANIC COMPOUNDS IN TWO POLLUTED RIVERS IN BARCELONA (CATA-LONIA, SPAIN).

Centro de Investigacion y Desarrollo, Barcelona (Spain). Dept. of Environmental Chemistry. J. I. Gomez-Belinchon, J. O. Grimalt, and J.

Albaiges. Water Research WATRAG, Vol. 25, No. 5, p 577-589, May 1991. 5 fig, 4 tab, 20 ref. Spanish National Plan for Research Grant NAT89-0927.

Descriptors: \*Barcelona, \*Coastal waters, \*Marine pollution, \*Path of pollutants, \*Spain, \*Stream pollution, \*Volatile organic compounds, \*Water pollution sources, Benzense, Besos River, Chlorinated hydrocarbons, Llobregat River, Naphthalenes.

The distributions of volatile organic compounds The distributions of volatile organic compounds (VOC) in two rivers flowing through heavily populated areas, Besos and Llobregat, were investigated. River waters were analyzed monthly for 13 months. Marine samples from the coastal area where the rivers discharge as well as from other coastal sites situated away from river influence were also studied. Petrogenic hydrocarbons, essentially C1-C5 alkylbenzenes and C8-C20 n-alkanes, are the major VOC present in these rivers (estimated annual discharge 260 metric tons). Chlorinated benzenes, C10-C13 alkylbenzenes, some terpenes and tributylohosphates are other main VOC with oenzenes, Clo-Cl3 aikyloenzenes, some terpenes and tributylphosphates are other main VOC with estimated outputs to seawater of 22, 14, 7 and 2 metric tons per year, respectively. The VOC concentrations in the rivers are generally between 2-3 centrations in the rivers are generally between 2-3 orders of magnitude higher than in the marine samples. The discharges of the Besos and Llobregat Rivers result in significant increases of C10-C13 alkylbenzenes, tributylphosphate, hexachlorobutadiene and chlorobenzenes to the nearby coastal area. However, in the case of petrogenic hydroards and area. carbons, the background concentration resulting from marine traffic and related activities developed in the area outnumbers the riverine contributio (Author's abstract) W91-10887

FATE OF ACETONE IN AN OUTDOOR MODEL STREAM WITH A NITRATE SUPPLEMENT, SOUTHERN MISSISSIPPI, U.S.A.

MENT, SOUTHERN MISSISSIFT, U.S.A. Geological Survey, Arvada, CO. R. E. Rathbun, D. W. Stephens, and D. Y. Tai. Journal of Hydrology JHYDA7, Vol. 123, No. 3/4, p 225-242, March 1991. 2 fig, 10 tab, 13 ref.

Descriptors: \*Acetone, \*Biodegradation, \*Fate of pollutants, \*Nitrates, \*Streams, Degradation, Nutrients. Traveltime.

The fate of acetone in an outdoor model stream to which nitrate was added as a nutrient supplement was determined. The stream, in southern Mississippi, was 234 m long. Water was supplied to the stream by an artesian well at about 1.2 L/s, result-

ing in a mean water velocity of about 20-40 mg/L ing in a mean water velocity of about 20-40 mg/L.

A nitrate solution was injected continuously for 26
days resulting in concentrations of about 1.7 mg/L
at the upstream end of the stream. Rhodamine-WT
dye was used to determine the travel time and
dispersion characteristics of the stream, and t-butyl
alcohol was used to determine the volatilization
characteristics. Volatilization controlled the fate of acetone in the model stream. The lack of substan tial bacterial degradation of acetone was contrary to expectations based on the results of laboratory degradation studies using model stream water enriched with nitrate. A possible explanation for the lack of significant degradation in the model stream may be the limited 6-h residence time of the accetone in the stream. (Author's abstract) W91-10903

HYDROGEOCHEMICAL PROCESSES CONTROLLING SUBSURFACE TRANSPORT FROM AN UPPER SUBCATCHMENT OF WALKER BRANCH WATERSHED DURING STORM EVENTS, 1. HYDROLOGIC TRANSPORTED TRANSPORTED TO TRANSPORTE PORT PROCESSES

essee Univ., Knoxville. Dept. of Plant and Soil Science

. Wilson, P. M. Jardine, R. J. Luxmoore, L. W. Zelazny, and D. A. Lietzke.

Journal of Hydrology JHYDA7, Vol. 123, No. 3/4, p. 297-316, March 1991. 11 fig. 1 tab, 24 ref. U.S.

Department of Energy Contract DE-ACO5-

Descriptors: "Acid rain effects, "Forest watersheds, "Geochemistry, "Groundwater movement, "Hydrology, "Path of pollutants, "Storm seepage, "Stream pollution, "Subsurface water, "Water chemistry, "Watersheds, Acid rain, Flow, Perched water table, Porosity, Rainfall, Saturated flow, Soil properties, Streams, Water, table, chemistry, Soil properties, Streams, Water, table

chemistry, Soil properties, Streams, Water table.

Concerns over the effects of acid rain have stimu lated numerous hydrometric and geochemical studies on forested watersheds with an emphasis on stream water chemistry. However, integrated stud-ies are seriously lacking, and inferences on soil hydrogeochemical processes from periodic stream water chemistry may be grossly misleading. A small forested subcatchment was intensively instrumented for hydrologic and chemical analyses to improve the understanding of the processes that control subsurface transport of solutes. The timing and volume of subsurface flows were found to be highly dependent upon soil hydromorphologic properties. Development of perched water tables was the predominant mechanism of subsurface through the lower layers during moderate to flow through the lower layers during moderate to high flow events. Perching of water was insignificant during low flow events and only partially responsible for lateral flow through the upper soil layers during moderate events. The importance of non-equilibrium conditions during even low flow events was illustrated by the occurrence of saturated flow through unsaturated (matric potentials < 2 Pa) soil. The initial subsurface flow response of a moderate and high flow event was predominantly (>70%) new water that bypassed the soil matrix. As flows continued the percentage of old water increased. Intermittent rainfall during the high flow event caused multiple peaks in subsurface flow with subtle increases in perching. This sugflow with subtle increases in perching. This sug-gests an increase in the portion of infiltrating water gests an increase in the portion of the macropores that bypasses soil matrix water via macropores causing increases in subsurface flow with limited growth of perched water tables. The persistence of perched water tables as flow decreased was con-sistently observed. Decreases in solute concentrations causes decreases in conductivity of pores was inferred as one mechanism for this. (See also W91-10908) (Author's abstract)

HYDROGEOCHEMICAL PROCESSES CON-TROLLING SUBSURFACE TRANSPORT FROM AN UPPER SUBCATCHMENT OF WALKER BRANCH WATERSHED DURING STORM EVENTS. 2. SOLUTE TRANSPORT PROCESSES

essee Univ., Knoxville. Dept. of Plant and Soil Science G. V. Wilson, P. M. Jardine, R. J. Luxmoore, L.

W. Zelazny, and D. E. Todd. Journal of Hydrology JHYDA7, Vol. 123, No. 3/ 4, p 317-336, March 1991. 11 fig, 2 tab, 30 ref. U.S. of Energy Contract DE-ACO5-

Descriptors: \*Acid rain effects, \*Geochemistry, Descriptors: "Acid rain effects, "Geochemistry, "Groundwater movement, "Path of pollutants, \*Solute transport, "Storm seepage, "Subsurface water, \*Watersheds, Hydrographs, Infiltration, Kinetics, Mass balance, Nutrients, Porosity, Slopes, Soil chemistry, Soil water, Suspended solids.

Geochemical studies of transport from watersheds have focused on stream chemistry and/or soil lynave locused on stream chemistry and/or soil lysimeter data to interpret soil processes. Direct measurements of subsurface transport of solutes from hillslopes during storm events and integration with hydrometric analyses is seriously lacking. The subsurface transport of solutes (K, Ca, Mg, Mn, Fe, Al, Na, SO4, and Si) from a 0.47 ha hillslope subcatchment of the west fork of Walker Branch watershed for six storm events is presented. Transport of Fe and Al was primarily as suspended particles which resulted in a very rapid increase in their concentrations at the initiation of subsurface flow. Weathering via particle detachment (i.e., sus-pended particles) was believed to be due to rapid pended particles) was beneven to be use of infiltration of new water of low ionic strength which increases the diffuse double layer facilitating detachment of particles. The concentration of Fe and Al in filtered solutions increased as flow and decreased during the recession limb of the hydrograph. The mechanisms for the increase then decrease is believed to be electrostatic exchange from surfaces of conducting pores followed by a kineti-cally controlled release via mineral decomposition. most commonly observed solute transport pattern during storm events was an increase in contern during storm events was an increase in centration as flow rate increased, followed by a decrease in concentration during the recession limb of the hydrograph. This response was due to flush-ing of solutes primarily from water-filled mesopores with macropores serving as conduits for solutes with limited attenuation. A mass balance of solutes was computed for the subcatchment for 1988, and subsurface storm flow through the upper soil profile resulted in only a minor export of deposited solutes. However, subsurface saturated flow during individual storms were shown to be significant exporters of nutrients. (See also W91-10907) (Author's abstract) W91-10908

NITRATE REMOVAL BY DENITRIFICATION IN ALLUVIAL GROUND WATER: ROLE OF A FORMER CHANNEL.

Centre National de la Recherche Scientifique, Toulouse (France). Centre d'Ecologie des Res-sources Renouvelables.

E. Fustec, A. Mariotti, X. Grillo, and J. Sajus. Journal of Hydrology JHYDA7, Vol. 123, No. 3/ 4, p 337-354, March 1991. 8 fig. 2 tab, 55 ref.

Descriptors: \*Agricultural runoff, \*Alluvial plains, \*Channels, \*Denitrification, \*Fate of pollutants, \*Groundwater, \*Nitrates, \*Path of pollutants, \*Subsurface water, \*Water chemistry, Cultivated lands, Dikes, Drying, Iron, Isotopic tracers, Man-ganese, Meanders, Surface-groundwater relations, Variability, Waterlogging, Wetlands.

A study was conducted to determine the capacity A study was conducted to determine the capacity of a former channel in removing nitrate from the groundwater and to estimate the possible long-term disturbances which can be caused by the diking up of this meander. Chemical variations of groundwater in an against measure of the Care groundwater in an ancient meander of the Garome River (southern France) were compared with that of groundwater located under the intensively culti-vated fields of the surrounding alluvial plain. Ni-trate, Mn(II), and Fe(II) concentrations were found to be very different in the two situations. The denitrification process in the former channel was identified through the natural N-15 isotope was identified intrough the natural N-15 isotope fractionation and by the in situ measurement of gaseous nitrogen losses using the acetylene method. A recent embankment leads to the progressive drying of the waterlogged soils thereby decreasing the capacity of this natural riparian

#### Group 5B-Sources Of Pollution

wetland to regulate nitrate transfers from the agricultural plain to the river. (Author's abstract) W91-10909

TRANSFORMATION OF (C-14)-2,4-DICHLOR-OPHENOL IN SASKATCHEWAN SOILS, Agriculture Canada, Regina (Saskatchewan). Reearch Station.

Search Station.

A. E. Smith, and A. J. Aubin.

Journal of Agricultural and Food Chemistry

JAFCAU, Vol. 39, No. 4, p 801-804, April 1991. 2 tab. 15 ref.

Descriptors: \*Biodegradation, \*Chlorinated hydrocarbon insecticides, \*Fate of pollutants, \*Pesticides, \*Radiochemical analysis, \*Saskatchewan, \*Soil contamination, Carbon dioxide, Herbicides, Radioactive tracers, Soil analysis, Soil organic

2,4-Dichlorophenol, in trace amounts, has been identified as a metabolite of the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) in laboratory soils although its isolation and identification in 2,4-D treated field soils remains to be demonstrated. The transformation of (C-14)-2,4-dichlorophenol in The transformation of (C-14)-2,4-dichlorophenol in four soils was investigated by measuring amounts of (C-14) carbon dioxide evolved, quantifying solvent-extractable C-14 products, and determining the incorporation of radioactivity into soil organic matter. Over a 14-day period in four soils with no recent herbicide history, 12-17% of the applied C-14 was released as carbon dioxide, 5-23% of the initial radioactivity was solvent recoverable as (C-14)-2,4-dichloroanisole. Unknown volatile C-14 products and unidentified solvent-extractable C-14 compounds together accounted for 3-6% of the applied C-14. Between 44 and 68% of the initial radioactivity was associated with soil organic matter. The c-1+. Detween 44 and 68% of the initial radioactivity was associated with soil organic matter. The present studies indicate that should any 2,4-dichlorophenol come into contact with the soil as a result of 2,4-D metabolism, such residues would be rapidly dissipated. (Agostine-PTT) W91-10922

REMOBILIZATION OF CU FROM MARINE PARTICULATE ORGANIC MATTER AND FROM SEWAGE.

National Oceanic and Atmospheric Administra-tion, Seattle, WA. Pacific Marine Environmental

Lao.
A. J. Paulson, H. C. Curl, and E. D. Cokelet.
Marine Chemistry MRCHBD, Vol. 33, No. 1/2, p
41-60, April 1991. 4 fig. 4 tab, 29 ref. National
Oceanic and Atmospheric Administration Pacific Marine Environmental Laboratory Contribution

Descriptors: \*Copper, \*Heavy metals, \*Marine pollution, \*Organic matter, \*Particulate matter, \*Path of pollutants, \*Wastewater, Decomposition, Diffusion, Effluents, Flocculation, Ion exchange, Puget Sound, Sediments

The possible causes of enrichments of dissolved Cu in the bottom waters of Puget Sound were examined in a series of experiments designed to measure the release of Cu from surface marine organic suspended matter and from sewage-derived particles under ambient conditions. Decomposition of organic matter and ion-exchange controlled the release of about one-third of the Cu bound to large particles ( > 53 micrometer). In contrast, no Cu was released from smaller particles ( < 53 micrometers) suspended in natural seawater and only 5% of the Cu on small particles was released into artificial seawater with a low dissolved Cu concentrations. or the Cu on small particles was released into artificial seawater with a low dissolved Cu concentration. Within 15 min of mixing primary effluent with natural seawater, 40% of the dissolved Cu was lost from solution by flocculation. Between 15 min and 4 days, 25% of the total effluent Cu was released back into solution. This release could have critical efficiency of the control originated either from particulate Cu on the original sewage particles or from the flocculated Cu that was formed from dissolved Cu within the first that was formed from dissolved Cu within the first 15 min. The release of Cu into the bottom waters of Puget Sound from settling marine organic matter was calculated to between 1 and 8 microgram Cu/sq-m day, which is comparable with the diffusion of Cu from sediments. In contrast, the

release of sewage-derived Cu could have been as high as 725 microgram Cu/sq-m day within 10 km of outfall. (Author's abstract) W91-10923

DISTRIBUTION OF DISSOLVED CADMIUM, LEAD AND COPPER IN THE BRISTOL CHAN-NEL AND THE OUTER SEVERN ESTUARY. Ministry of Agriculture, Fisheries and Food, Burn-ham on Crouch (England). Fisheries Lab. D. I Harper.

nam on Stoute Carlon Records of the Control of the Chemistry MRCHBD, Vol. 33, No. 1/2, p 131-143, April 1991. 5 fig, 18 ref.

Descriptors: \*Cadmium, \*Copper, \*Estuarine environment, \*Heavy metals, \*Lead, \*Path of pollutants, \*Water pollution sources, Bristol Channel, Chemical properties, Distribution patterns, Industrial wastes, Salinity, Severn Estuary.

A reassessment of trace metal distributions around the English and Welsh coastlines has been under-taken by the Ministry of Agriculture, Fisheries and Food's laboratory at Burnham-on-Crouch. As part of this series of surveys, one cruise included an on this series of surveys, one cruise included an investigation of trace metal levels in the Bristol Channel and outer Severn Estuary. The sampling covered an area from Avonmouth in the east to a north-south transect at 5 degrees west. Seawaters in regions that were known to receive a significant anthropogenic input, such as Swansea Bay and the Severn estuary, were sampled more intensively than in regions with little or no input from industry. In October 1987 63 samples were taken from 50 stations in the Bristol and outer Severn estuary 30 stations in the Bristol and outer Severn estuary on the west coast of England. The distributions of dissolved cadmium, lead and copper are reported together with their relationships to salinity. The concentration ranges are 11-140 ng/L for cadmium, 20-10000 ng/L for lead and 1.7-4.7 microgram/L for copper. In high-salinity areas, higher cadmium and copper concentrations users found to cadmium and copper concentrations were found to be associated with local inputs, but the situation with respect to lead was found to be more compli-cated. At lower salinities, lead and copper distribu-tions show several anomalies as a result of processtions show several anomanes as a least of processes other than dilution. The data obtained at low salinities may not be typical, because the survey was carried out after a period of unusually high winds and rainfall. (Agostine-PTT) W91-10925

NON-POINT SOURCE LOADINGS OF NUTRI-ENTS AND DISSOLVED ORGANIC CARBON FROM AN AGRICULTURAL-SUBURBAN WA-TERSHED IN EAST CENTRAL FLORIDA. Florida Inst. of Tech., Melbourne. Dept. of Chemi-cal and Environmental Engineering.

F. E. Dierberg. Water Research WATRAG, Vol. 25, No. 4, p 363-374, April 1991. 8 fig, 5 tab, 23 ref.

Descriptors: \*Agricultural watersheds, \*Florida, \*Nonpoint pollution sources, \*Organic loading, \*Suburban areas, \*Urban runoff, \*Water pollution sources, Canals, Dissolved organic carbon, Drainage, Nutrient transport, Storms, Watersheds.

Unit area loadings for nitrogen, phosphorus dissolved organic carbon were measured from four sub-watersheds and the entire 256 sq-km catchment area tributary to the Indian River Lagoon. The catchment area is a rapidly growing suburban area drained by 322 km of canals in east central Florida. One-third of the annual total nitrogen, one-half of the total phosphorus and one-fourth of the annual dissolved organic carbon were exported in the drainage canal water at the water control structure to downstream waters during a 6-week period when three major storms occurred. High annual loadings of dissolved inorganic (1.3 kg N/ha-yr) and organic (4.4 kg N/ha-yr) nitrogen were recorded for the rotational grazing sub-watershed; during storm search the entire discolved increasing during storm events, the entire dissolved inorganic nitrogen load leaving the catchment basin originated from the agricultural sub-watershed. Annual total nitrogen and total phosphorus export coefficients from the agricultural sub-basin deviated considerably from published 'national' averages, but were very similar to 'regional' coefficients pub-lished for Wisconsin. Dissolved inorganic nitrogen and phosphorus had wide variances to the published 'regional' coefficients, emphasizing the need for site-specific studies. (Author's abstract) W91-10927

INCIDENCE OF LEGIONELLA IN URBAN ENVIRONMENT IN AUSTRALIA.

University of Technology-Sydney, Broadway.
Div. of Biological Sciences.
L. J. Hedges, and D. J. Roser. Water Research WATRAG, Vol. 25, No. 4, p 393-399, April 1991. 5 tab, 26 ref.

Descriptors: \*Australia, \*Domestic water, \*Epidemiology, \*Legionella, \*Path of pollutants, \*Urban areas, Climates, Geography, Air conditioning, Pathogens, Pollutant identification, Water quality

Extensive sampling of the built environment was undertaken to determine the extent of Legionella presence in different regions of New South Wales. Distribution and abundance of Legionella in N.S.W. were found to be similar to those found in Europe and North America, despite Australia's present all inserts and generating indiction. warmer climate and geographical isolation. Air conditioning cooling towers, warm water systems and spas showed the highest incidence of Legion-ella (32, 37 and 36% respectively). Legionella ophila serotypes predominated, being in 82% of the positive samples examine pneumophila being Seasonality in isolation patterns was not detected.
The Illawarra Health Region, where a major out-break has recently occurred, was found to have the lowest incidence of Legionella, probably due to improved maintenance measures undertaken in the aftermath of the outbreak. It was concluded that the distribution and abundance of Legionella in the the distribution and abundance of Legionelia in the south-eastern part of Australia follows a comparable pattern to elsewhere in the world and that measures to prevent outbreaks of Legionnaire's disease should be similar to those currently being introduced in the U.S.A. and Great Britain. (Author's abstract)

RIPARIAN ZONE AS A SOURCE OF PHOS-PHORUS FOR A GROUNDWATER-DOMINAT-ED LAKE.

Lund Univ. (Sweden). Dept. of Ecology. For primary bibliographic entry see Field 2H.

DYNAMIC MODEL OF CAESIUM TRANS-PORT IN LAKES AND THEIR CATCHMENTS. Institute of Hydrology, Wallingford (England). S. McDougall, J. Hiltlon, and A. Jenkins. Water Research WATRAG, Vol. 25, No. 4, p 437-445, April 1991. 6 fig, 1 tab, 18 ref.

Descriptors: \*Cesium, \*Cesium radioisotopes, \*Fallout, \*Lakes, \*Model studies, \*Path of pollut-ants, \*Watersheds, Air pollution effects, Chernobyl accident, Epiliminon, Fish, Hypolimnion, Runoff, Sedimentation, Suspended solids.

A mathematical model has been developed to predict radiocesium concentrations over time within individual compartments of a lake and its catch-ment. The lake is divided into five compartments; (1) catchment, lake water ((2) epilimnion and (3) hypolimnion during stratification), (4) lake sediment and fish. Radiocesium enters the lake via contaminated rainfall and catchment runoff. A proportion of the radiocesium absorbs onto suspended solids in the lake. This proportion is represented by a distribution coefficient. Sedimentation of the suspended solids occurs at a rate defined by the areal removal coefficient and results in increased cesium removal coefficient and results in increased cesium concentrations in the sediment. The ingestion of radiocesium by either water column or benthic feeding fish is described by transfer functions. The model has been tested against data collected from Esthwaite water and Windermerer shortly after the Chernobyl reactor accident from May 1986 to December 1987. The model simulates observed radiocesium concentrations in Esthwaite lake water and sediment and also in lake water, sediment and fish in Windermerer. The model could ment and fish in Windermere. The model could

#### Sources Of Pollution-Group 5B

form the basis of a valuable management tool for the water industry should a major airborne pollu-tion ever occur again. (Author's abstract)

SEASONAL CHANGES IN THE SANITARY BACTERIAL QUALITY OF WATER DRAIN-ING A SMALL UPLAND CATCHMENT IN THE YORKSHIRE DALES.

Leeds Polytechnic (England). School of the Envi-

C. Hunter, and A. McDonald. Water Research WATRAG, Vol. 25, No. 4, p 447-453, April 1991. 3 fig, 4 tab, 20 ref.

Descriptors: \*Animal wastes, \*Bacteria, \*Drainage area, \*England, \*Nonpoint pollution sources, \*Path of pollutants, \*Watersheds, Cattle, Coliforms, Overland flow, Rainfall, Sheep, Soil contamination, Water quality management, Water quality monitoring.

The fecal coliform concentration of overland flow The fecal coliform concentration of overland flow and streamwater within a small catchment in the Yorkshire Dales was monitored over a 2 year period. Strong and consistent seasonal trends in bacterial concentrations were found. During the height of summer (mid June to the end of August), fecal coliform concentrations in streamwater were found to be significantly higher than at other times of the year. Consistently low concentrations were found during winter months. These trends closely followed those identified for semi-permanent overland flow, suggesting a direct causal link between streamwater quality and the bacterial concentraand now, suggesting a direct causar into detween streamwater quality and the bacterial concentra-tion of overland flow entering the stream channel. The seasonal trends identified were explained with respect to long term changes in the size of the store respect to long term changes in the size of the store of enteric bacteria existing in the surface soils of the catchment. Changes in land store size were related to seasonal changes in the frequency and amount of rainfall input to the catchment. The implications of the research findings for the management of upland catchments used for water supply or recreation are discussed. The most obvious potential solution to this problem would be to reduce substantially the influence of semi-permanent overland flow. This could be achieved by (1) lowering the water table close to stream channels through the installation of drainage systems or (2) through the installation of drainage systems or (2) to exclude sheep or cattle access (through fencing) from those catchment areas most frequently involved in the generation of overland flow. (Author's abstract) W91-10935

BIOAVAILABILITY OF ORGANIC POLLUT-ANTS IN BOREAL WATERS WITH VARYING LEVELS OF DISSOLVED ORGANIC MATERI-

AL. Joensuu Univ. (Finland). Dept. of Biology. J. Kukkonen, and A. Oikari. Water Research WATRAG, Vol. 25, No. 4, p 455-463, April 1991. 8 fig, 4 tab, 38 ref. Academy of Finland/Research Council for Environmental Sciences project no. 06/133.

Descriptors: \*Bioavailability, \*Cold regions, \*Dis-solved solids, \*Hydrophobic compounds, \*Organic pollutants, \*Path of pollutants, Benzopyrene, Fin-land, Physical properties, Polycyclic aromatic compounds, Surface water, Waterfleas.

Dissolved organic matter (DOM) in 20 surface waters in Eastern Finland were characterized to examine relationships between structural and compositional properties of DOM and partition coefficients (Kp) describing sorption of four model contaminants to DOM and the bioavailability of contaminants by Daphnia magna. The hydrophobic acids (HbA), hydrophobic neutrals (HbN) and hydrophiolic (HI) fractions were separated by XAD-8 resin. The Kps were measured by equilibrium dialysis. Model contaminants were benzo(a)pyrene (BaP), naphthalene (NAPH), 3,3',4,4'-tetrachlorobiphenyl (TCB) and dehydroabietic acid (DHAA). DOM concentrations varied from 2.0 to 38.3 mg org. C/L in the water series. The percentage of HbA and the aromaticity of DOM, as indicated by the absorptivity at 270 nm (A-270) and hydrogen/carbon ratio, increased with increasing DOM con-

centration. Significant correlations were observed between Kp of BAP, A-270 and HbA content of the DOM form different sources. For the other contaminants similar kinds of relationships between Kps and quality parameters of DOM could not be found. The bioavailability of model compounds was decreased by increasing DOM concentration in the water series. For all four model contaminants, measured bioconcentration factors correlated well with the A-270 of a water and HbA content of the DOM. These results show that the total DOM concentration is an important factor controlling the bioavailability of xenobiotics in natural waters. In addition to the quantity, the quality of DOM, like proportion of HbA, can contribute to bioavailability. (Author's abstract)

FACTORS AFFECTING THE RELATIONSHIP BETWEEN THE NBOD VALUES AND THE AMOUNTS OF NITROGENOUS POLLUT-ANTS: A FIELD STUDY ON THE LEE RIVER. Beijing Univ. (China). Dept. of Geography. For primary bibliographic entry see Field 5C. W91-10940

EVIDENCE OF CHERNOBYL FALLOUT ON A

EVIDENCE OF CHERNOBYL FALLOUT ON A TEMPERATE HIMALAYAN GLACIER. Physical Research Lab., Ahmedabad (India). V. N. Nijampurkar, and D. K. Rao. Current Science CUSCAM, Vol. 59, No. 23, p 1239-1241, 1990. 1 fig, 9 ref.

Descriptors: \*Air pollution, \*Chernobyl, \*Fallout, \*Glaciers, \*Himalayas, \*India, \*Nuclear accidents, Air pollution effects, Alps, Path of pollutants, Radioactive wastes, Snow sampling, Soviet Union.

Several snow/ice samples collected in August 1987 from Chhota Shigri glacier, in the Indian Himalayas, were analyzed for total beta and gamma activities to see if any fallout from the Chernobyl, anyas, were analyzed for total beta and gamma activities to see if any fallout from the Chernobyl, nuclear accident in April 1986 was deposited in the Himalayan region. It was found that the activities in snow samples were higher, by a factor of about 15, than those observed in old ice samples. These activities were mainly in the hump region of the glacier located in the altitude band 4150 to 4650 m. The total activities are much lower, as expected, than those observed in the Alps, which indicates that a very small fraction of the Chernobyl fallout was deposited over the Himalayas as compared to that in the Alps. These results are the first evidence of Chernobyl fallout deposition on Chhota Shigri glacier. The radioactivity must have eventually been diluted with large volumes of air in the atmospheric reservoir before deposition in the Himalayan region. (Fish-PTT)

PROSPECTING FOR ZONES OF CONTAMINATED GROUND-WATER DISCHARGE TO STREAMS USING BOTTOM-SEDIMENT GAS BUBBLES.

Geological Survey, Columbia, SC. Water Resources Div.

D. A. Vroblesky, and M. M. Lorah. Ground Water GRWAAP, Vol. 29, No. 3, p 333-340, May/June 1991. 6 fig, 23 ref.

Descriptors: \*Bubbles, \*Groundwater pollution, \*Maryland, \*Path of pollutants, \*Volatile organic compounds, \*Water pollution sources, Analytical methods, Bottom sediments, Chloroform, Decom-posing organic matter, Fluvial sediments, Gases, Trichloroethylene.

Because the installation of observation wells at sites of groundwater contamination is expensive and proper placement of wells is necessary to ensure that suspected contaminant plumes are intercepted, reconnaissance methods that can intercepted, reconnaissance methods that can detect and delineate possible areas of groundwater contamination are important to the design of a cost-efficient and functional monitoring network. Decomposition of organic-rich bottom sediment in a tidal creek in Maryland results in production of gas bubbles in the bottom sediment during summer and fall. In areas where volatile organic contaminants discharge from groundwater, through the

bottom sediment, and into the creek, part of the volatile contamination diffuses into the gas bubbles and is released to the atmosphere by ebullition. Collection and analysis of gas bubbles for their volatile organic contaminant content indicate that volatile organic contaminant content indicate that relative concentrations of the volatile organic contaminants in the gas bubbles are substantially higher in areas where the same contaminants occur in the groundwater that discharges to the streams. Analyses of the bubbles located an area of previ-Analyses of the bubbles located an area of previously unknown groundwater contamination. The method developed consisted of disturbing the bottom sediment to release gas bubbles, and then capturing the bubbles in a polyethylene bag at the water-column surface. The captured gas was transferred either into sealable polyethylene bags for immediate analysis with a photoionization detector or by syringe to glass tubes containing wires coated with an activated-carbon adsorbent. Relative consentations were determined by some seasons. tive concentrations were determined by mass spec-tral analysis for chloroform and trichloroethylene. (Author's abstract) W91-10951

CHARACTERISTICS OF RHODAMINE WT AND FLUORESCEIN AS ADSORBING GROUND-WATER TRACERS.

Oklahoma Univ., Norman. School of Civil Engi-Okianoma Univ., Norman, School of Civil Engineering and Environmental Science.
D. A. Sabatini, and T. A. Austin.
Ground Water GRWAAP, Vol. 29, No. 3, p 341-349, May June 1991. 8 fig, 6 tab, 23 ref.

Descriptors: \*Chemical tracers, \*Dye releases, \*Dyes, \*Path of pollutants, \*Pesticides, \*Solute transport, \*Tracers, Adsorption, Alachlor, Atrazine, Groundwater movement, Herbicides, Sand

Fluorescent dyes are being used as adsorbing groundwater tracers for conducting solute transport studies for adsorbing organic chemicals (e.g., pesticides). The ability of two fluorescent dyes (rhodamine WT and fluorescein) to mimic the adventise and the adventise of the behinder (strains and the adventise of the behinder of the period of the period of the adventise of the behinder of the period of the adventise of the period of the (rhodamine WT and fluorescein) to mimic the ad-sorptive behavior of two herbicides (atrazine and alachlor) with alluvial aquifer sands was evaluated. Laboratory studies (batch and column) indicated the following order of increasing adsorption: fluo-rescein, atrazine, alachlor, and rhodamine WT. Thus, the use of fluorescein and rhodamine WT as adsorbing groundwater tracers was observed to delimit the appearance of the atrazine and alachlor (fluorescein; anneared before and rhodamine WT. delimit the appearance of the atrazine and alachlor (fluorescein appeared before and rhodamine WT after the herbicides). Several adsorption characteristics of the fluorescent dyes differed from those commonly observed for pesticides. The levels of adsorption for the dyes were several orders of magnitude greater than predicted from empirical relationships based on the octanol-water partition coefficient and the function of the organic carbon content of the material. The presence of divalent cations was observed to increase the level of rhodamine WT adsorption. The rhodamine WT break-through curves were not of the conventional significant of the several conventional significant carbon contents. through curves were not of the conventional sig-moidal shape but instead leveled off at a carbon to moidal shape but instead leveled off at a carbon to carbon monoxide ratio (C/CO) value of 0.5 for a number of pore volumes prior to increasing again towards a C/CO value of 1.0. These characteristics indicate that the adsorptive mechanisms for the fluorescent dyes differed from the adsorptive mechanisms for most pesticides. These variations in fundamental adsorptive mechanisms raise concerns as to the transferability of the results of this research (fluorescein and rhodamine WT delimiting the appearance of atrazine and alachlor) to other subsurface media. (Author's abstract)

DELINEATION OF A DISCONTINUOUS AQUITARD WITH VERTICAL ELECTRICAL SOUNDINGS, SAN BERNARDINO VALLEY, SOUTHERN CALIFORNIA.

California Univ., Riverside. Inst. of Geophysics

and Planetary Physics.
W. P. Owen, S. K. Park, and T. C. Lee.
Ground Water GRWAAP, Vol. 29, No. 3, p 418424, May June 1991. 11 fig. 16 ref.

Descriptors: \*California, \*Electrical surveys, \*Geophysical surveys, \*Groundwater pollution,

#### Group 5B-Sources Of Pollution

\*Path of pollutants, \*Solute transport, \*Subsurface mapping, Electrical equipment, Water table gradi-ent, Water table profiles.

Vertical electrical soundings were used to map the vertual recent a soundings were used to map the presence or absence of an aquitard separating a shallow, contaminated aquifer from a deeper, uncontaminated one in San Bernardino Valley, California. Correlation of vertical electrical soundings with lithologic logs from adjacent wells allowed mapping of local variations in the elevation of the water table. Comparison of known waste sites, the distribution of the aquitard, and elevation of the water table yielded probable directions of contaminant transport. It was concluded that there is a significant hazard to municipal water wells due to possible transport of contaminants between the shallow and deeper aquifers. (Author's abstract) W91-10960

GREAT LAKES TOTAL PHOSPHORUS MODEL: POST AUDIT AND REGIONALIZED SENSITIVITY ANALYSIS.

Argonne National Lab., IL. Environmental Research Div. For primary bibliographic entry see Field 2H. W91-10974

POLYCHLORINATED BIPHENYLS IN DATED SEDIMENT CORES FROM GREEN BAY AND

LAKE MICHIGAN.
Wisconsin Univ.-Milwaukee. Dept. of Civil Engi-

M. H. Hermanson, E. R. Christensen, D. J. Buser, and L. M. Chen.

Journal of Great Lakes Research JGLRDE, Vol. 17, No. 1, p 94-108, 1991. 8 fig. 3 tab, 51 ref. U.S. Environmental Protection Agency assistance agreement R810419; U.S. National Science Foundation Grant No. CES-8701184.

Descriptors: \*Core analysis, \*Green Bay, \*Lake Michigan, \*Lake sediments, \*Polychlorinated biphenyls, \*Water pollution sources, Air pollution, Dating, Great Lakes, Radioactive dating, Sedi-

Widespread use of polychlorinated biphenyls (PCB) in industrial and consumer products for nearly 50 years between 1929 and 1977 has resulted in the presence of this class of compounds in every environmental compartment. Ten sediment cores from Lake Michigan and Green Bay were ana-lyzed for PCB, 210-Pb, and 137-Cs. Analyses in-cluded identification of historical patterns of PCB inputs to the lake and bay and estimation of histori-cal annual average PCB fluxes to the sediment that cal annual average PCB fluxes to the seatment that were corrected for sediment redistribution (focus correction). A correction for focusing has not been utilized in previous investigations of PCB flux to Lake Michigan and Green Bay sediments. From these analyses, it was concluded that PCB inputs have declined following the 1977 ban on new used of PCB, and that the strosphere is the largest of PCB, and that the atmosphere is the largest source of PCB to parts of Lake Michigan. It is estimated that the average annual atmospheric flux to the Lake Michigan region is about 1.0 ng/sq cm/yr, plus-or-minus 0.34, which is the approxi-mate flux to three of five Lake Michigan cores. This amount is consistent with another recent flux This amount is consistent with another recent flux estimate. Green Bay sediments have higher PCB concentrations and greater relative amounts of lower molecular weight PCB (Aroclor 1242) than lake sediments which are dominated by Aroclor 1254. Aroclor 1260 is also found in Green Bay but not observed in the lake. PCB concentrations in Green Bay sediment are highest near the mouth of the Fox River, and decline in areas of the bay where the Fox River plume is more dispersed. Atmospheric inputs account for no more than 11% of PCB flux to any Green Bay core analyzed. (Author's abstract) (Author's abstract) W91-10979

PHOSPHORUS FROM INTERNAL SOURCES IN THE LAURENTIAN GREAT LAKES, AND THE CONCEPT OF THRESHOLD EXTERNAL LOAD.

Freshwater Research, R.R. 1, Baysville, Ontario P0B 1A0.

G. K. Nurnberg. Journal of Great Lakes Research JGLRDE, Vol. 17, No. 1, p 132-140, 1991. 2 fig, 4 tab, 32 ref.

Descriptors: \*Great Lakes, \*Lake sediments, \*Limnology, \*Phosphorus, \*Pollution load, \*Limnology, \*Phosphorus, \*Pollution load, \*Water pollution sources, Anoxic conditions, Eutrophication, Hypolimnion, Nutrient transport, Sediments, Trophic level.

The trophic status of the Laurentian Great Lakes is greatly influenced by phosphorus (P) derived from anoxic sediment surfaces. Data from the Great Lakes and data from smaller lakes of Eastern North America can be used to demonstrate how such an internal P load influences trophic state. To facilitate predictions for the future of the Great Lakes or any lake subjected to P release from anoxic sediment surfaces, the concept of 'threshold external load' is introduced. The external P load at which the flux downward from external sources matches the flux upward from anoxic sediments can be considered the 'threshold external load.' The product of the 'threshold external load.' the Ine product of the 'threshold external load,' the gross P retention (predicted from the annual water load) and the ratio of lake surface area to hypolimnetic area (a sediment focusing factor) yields the anoxic P release. The concept of 'threshold external load' helps explain the slow response of certain lakes to phosphorus input abatement. (Author's obstract)

BOUNDARY ELEMENT AND PARTICLE TRACKING MODEL FOR ADVECTIVE TRANSPORT IN ZONED AQUIFERS. Thessaloniki Univ., Salonika (Greece). School of

Technology.

For primary bibliographic entry see Field 2F. W91-10997

LEACHING OF AMMONIUM NITRATE UNDER FIELD CONDITIONS: STUDIES ON KINETICS OF NITRIFICATION AND NITRATE REDUCTION IN AN ULTISOL PRO-

Orissa Univ. of Agriculture and Technology, Bhubaneswar (India).

B. K. Mishra, and C. Misra. Journal of Hydrology JHYDA7, Vol. 124, No. 1/ 2, p 185-195, April 1991. 4 fig, 3 tab, 13 ref.

Descriptors: \*Ammonium, \*Leachates, \*Leaching, \*Nitrates, \*Nitrification, \*Path of pollutants, \*Solute transport, India, Nutrient transport, Sandy soils, Soil chemistry, Soil columns, Soil properties

Owing to microbial activity, NH4(+)-N present in, or added to, the aerobic surface soil layer is oxidized to NO3(-)-N, which, while moving through the underlying aerobic soil layers, may be denitrified to an extent depending upon the interplay of a number of factors influencing the behavior of microbes in the soil environment. The interplay of a number of factors influencing the behavior of microbes in the soil environment. The interplay of a number of factors influencing the behavior of microbes in the soil environment. ior of microbes in the soil environment. The simultaneous occurrence of nitrification and nitrate re-duction was studied by leaching solution pulses of MHANO3 through 9 cm long columns and natural field profile of Bhubaneswar, India, sandy loam soil (Ultisol). Employing known analytical solutions of transport equations relevant to conditions induced for the leaching experiments, the nitrate reduction rate constant was estimated to be 0.072/. h at 28 C based on the breakthrough curve (BTC) of NO3(-)-N stemming from the soil column through which Ca(NO3)2 was leached. Using this value of the nitrate reduction constant, the value of nitrification rate constant was estimated to be 0.06/ h by curve fitting the NO3(-)-N BTC derived from NH4NO3 leaching in an equivalent soil column. Using values of the nitrate reduction constant close to that derived from the laboratory column studies, the nitrification rate constant was evaluated to be 0.1/h and 0.04/h for 0-30 and 0-50 cm soil layers, respectively, under field situations. (Author's abstract) W91-10999

OIL SPILL RISK SIMULATION MODEL. Kuwait Inst. for Scientific Research, Safat. Envi-ronmental and Earth Sciences Div.

Journal of Waterway, Port, Coastal and Ocean Engineering (ASCE) JWPED5, Vol. 117, No. 3, p 285-300, May/June 1991. 8 fig, 2 tab, 22 ref.

Descriptors: \*Computerized maps, \*Model studies, \*Oil slicks, \*Oil spills, \*Path of pollutants, \*Risk assessment, \*Simulation analysis, Coastal waters, Coastal zone management, Mapping, Markov process, Probabilistic process, Spills, Time series analysis, Wind-driven currents.

Oil spills are a major environmental concern in coastal regions. Most oil-slick models consider the coalsair regions in the collision of collisions movement a primarily deterministic mechanism, useful for hindcasting spill movement. When it comes to the problem of forecasting, however, oil-slick movement should be statistically simulated. A simulation numerical model has been simulated. A simulation fundered indoor has been developed that can generate an oil-risk map for a given area. The map shows monthly and yearly probabilities of oil-slick presence for each grid area. The probability computation procedure includes the oil-slick movement at each time stage cludes the oil-sinck movement at each time stage until it completes the given time interval. An ex-ample was examined to generate the Kuwait oil-spill risk map by using the simulation model. The results of the oil-spill risk map can be used to determine the relative sensitivities of coastal sec-tions where oil-slick occurrence are most probable. nons where outsince occurrence are most probable. The decision maker can use this information for strategic planning in environmental protection and for selecting sites for seawater intakes, fish farms, and coastal recreation areas. The model simulates a spill's location, size, and associated movement based on statistical data. Horizontal wind vector components are simulated using a Markovian time series model based on local wind statistics. The simulation of the slick's movement includes the mechanisms of spreading and drift by wind and currents. (Author's abstract) W91-11001

POLITICAL ECONOMIC MODEL OF INTER-NATIONAL POLLUTION

Minnesota Univ., St. Paul. Dept. of Agricultural and Applied Economics.

H. Von Witzke, and M. L. Livingston.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 119-128, 4 fig,

Descriptors: \*Economic aspects, \*Great Lakes, \*International waters, \*Model studies, \*Path of pollutants, \*Political aspects, \*Water pollution sources, \*Water quality, Costs, Industrial wastes, International agreements. Interstate commissions.

International pollution (externalities that cross po-International poliution (externations that cross po-litical jurisdictions) represents one of the most economically and politically complex problems. Calls for institutional changes that reduce interna-tional pollution grow with economic development and the accumulation of environmental degradation. Single countries, however, can supply them-selves with such institutions only in cooperation with other countries. Therefore, any solution to the problem requires explicit recognition of both political and economic aspects involved. Under-standing the political and economic determinants standing the pointed and economic determinants of existing water quality regulations is an important precondition for the development of feasible policy strategies that can lead to improved water quality in the Great Lakes. A public choice model is presented that captures the incentive structures faced by resource users, and the marginal political and economic benefits and costs of regulation. The precific conditions which give rice to calificial to the conditions which give rice to conditions which give and economic benefits and costs of regulation. The specific conditions which give rise to political cooperation or conflict are also specified. Hypotheses concerning the optimal degree of regulation as viewed by individual jurisdictions are posited with regard to: (1) the relative political strength of producers and consumers; (2) the transaction costs faced by each group; (3) structure of the input market; (4) relative size of the polluting industries involved; (5) level of economic development; and (6) the amount of the externality is properted; to or (6) the amount of the externality 'exported' to or 'imported' from other states or provinces. This analysis suggests a number of reasons for the exist-

### Sources Of Pollution—Group 5B

ence of policies that allow the private sector to deviate from the social optimum if there are exter-nalities in production. If part of the domestically produced externality is 'exported' to third countries, total domestic output of the externality is higher than in the case in which the total domestic higher than in the case in which the total domestically production of the externality is consumed domestically. The existence of an externality from abroad leads to a lower domestic output of the externality and a higher total consumption of the externality. This represents an incentive for policy coordination. The existing incentives for policy cooperation, however, do not imply that international coperation actually will occur. For this to happen, issues of fairness of the distribution of benefits of such agreements among countries will have to be such agreements among countries will have to be fully addressed. (See also W91-11003) (Lantz-PTT) W91-11016

ROAD SALTING IMPACTS IN MASSACHU-

Normandeau Engineers, Inc., Concord, NH For primary bibliographic entry see Field 4C. W91-11053

HEAVY METAL TRANSPORT TO THE GREAT LAKES BY NATURAL GROUND-WATER DISCHARGE: AN INITIAL EVALUATION.

Syracuse Univ., NY. Dept. of Geology.
D. I. Siegel, S. Frape, A. Martini, R. Drimmie, and

R. Thomas. IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 605-613, 2 fig,

Descriptors: \*Geochemistry, \*Great \*Groundwater discharge, \*Heavy metals, \*Path of pollutants, \*Water pollution sources, Brines, Canada, Detroit River, Dissolved solids, Geohydrology, Groundwater movement, Groundwater pollution, Groundwater quality, Lake Erie, Lake Huron, Lake Michigan, Lake Ontario, Niagara River, United States

The introduction of heavy and other trace metals to the Great Lakes is a significant environmental problem affecting the United States and Canada. Past studies have focused on the transport of heavy Problem antecting the Office States and Canada. Past studies have focused on the transport of heavy metals to the lakes from rivers such as the Niagara and Detroit. These rivers receive contaminated groundwater mostly from shallow flow systems. However, groundwater flow systems in the bedrock formations located along the margins of Lakes Erie, Ontario, Michigan and Huron also discharge heavy metals to the lakes. This groundwater naturally has a high concentration of dissolved solids, up to hundreds of thousands of parts per million, and concentrations of heavy metals hundreds to thousands of times greater than those found in most contaminated rivers. It can be shown from a synthesis of data from regional groundwater flow models, geohydrologic field studies, and studies of brine chemistry, that heavy metal transport to the Great lakes by natural groundwater discharge may be equal to or even greater than heavy metal transport from contaminated rivers. (See also W91-11003) (Author's abstract) stract) W91-11062

STATISTICAL CHARACTERIZATION OF ATRAZINE RESIDUES IN SOUTHWESTERN ONTARIO GREAT LAKES TRIBUTARIES. Ontario Ministry of the Environment, Toronto. Water Resources Branch.

IN: International and Transboundary Water Resources Issues. American Water Resources Asso-ciation, Bethesda, Maryland, 1990. p 627-636, 9 fig,

Descriptors: \*Atrazine, \*Great Lakes Basin, \*Ontario, \*Path of pollutants, Grand River, Irrigation effects, Pesticides, Saugeen River, Seasonal variation, Spray irrigation, Thames River, Water pollu-

Previous studies have demonstrated the presence and persistence of atrazine, until recently Ontario's

most used pesticides, in the water courses draining Ontario's agricultural southwest. Water sample data for atrazine and its phyto-toxic metabolite desethylatrazine, gathered since 1981 at the outlets of 3 Great Lakes tributaries (the Grant, Thames of 3 Great Lakes tributaries (the Grant, Thames and Saugeen Rivers) were analyzed in order to develop more precise statistical models for long-term trend analysis and mass discharge estimation. Concentration series exhibit a sharp seasonal rise over the main spray period from May through August, Trend analysis and load estimation should August. Trend analysis and load estimation should also reflect discharge dependence which, although generally weak, is statistically significant over spring runoff and the main treatment period. The fate of atrazine in surface waters merits further study. (See also W91-11003) (Author's abstract) W91-11064

STUDIES ON ASSESSMENT OF WATER BAL-ANCE AND ITS QUALITY IN GURPUR RIVER BASIN, KARNATAKA STATE, INDIA. Mangalore Univ. (India). Dept. of Chemistry. M. R. Gajendragad, G. Ranganna, K. N. Lokesh, G. Chandrakantha, and K. Harshendra.

G. Chandrakantha, and K. Fiarsnehdra. IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 639-648, 2 fig, 4 tab, 4 ref.

Descriptors: \*Computer models, \*Environmental impact, \*Gurpur River Basin, \*Hydrologic budget, \*Land use, \*Water quality, Agriculture, Case studies, India, Trigation water, Model studies, Monsoons, Rainfall, Regression analysis.

Dakshina Kanada district which lies between the Arabian Sea and the Western Ghats (Sahyadri Mountain Chain) in southern India, remained un-derdeveloped until very recently, notwithstanding its rich natural resources. Of late, intense developmental activities have begun in the coastal region. mental activities nave begun in the coastal region. These have been putting a great strain on the fresh water potential of the district. Even though the district receives heavy annual rainfall, it faces water scarcity problems from early summer (March to May). An assessment of harnessible water potential has, therefore, become imperative. A case study was conducted in an attempt to assess the long-term average monthly computer progri Results indicate that the basin has a harnessi Results indicate that the basin has a harnessible potential of water, and that the untapped ground-water can be availed from the basin area, when the monsoon breaks, without disturbing agricultural activity. By making use of the surplus water, about 5,671 ha of unirrigated land can be brought under irrigation. Water quality studies indicate the presence of good quality water except in lower reaches where some of the wells are polluted due to salt water intrusion. The regression models developed for water quality are found to be highly useful in water intrusion. The regression modes developed for water quality are found to be highly useful in the prediction of water quality when it is not possible to analyze a large number of samples for all physicochemical characteristics of water. (See also W91-11003) (Lantz-PTT)

ENVIRONMENTAL PROBLEMS AND SOLU-TIONS: GREENHOUSE EFFECT, ACID RAIN,

POLLUTION.
Hemisphere Publishing Corporation, New York.
1990. 525p. Edited by T. Nejat Veziroglu.

Descriptors: \*Acid rain, \*Air pollution effects, \*Air pollution sources, \*Carbon dioxide, \*Global warming, \*Greenhouse effect, \*Oil spills, \*Path of pollutants, \*Radioactive wastes, \*Water pollution effects, \*Water pollution sources, Acidification, Air temperature, Climates, Clouds, Corrosion, Desertification, Drought, Estuaries, Flooding, Lakes, Rainfall, Rivers, Sea level.

Human activities have produced increasing amounts of destructive agents, including the green-house effect, acid rain, air pollution, radioactive pollutants, and oil spills. The large increase in carbon dioxide has initiated the greenhouse effect, which is thought to be responsible for the rise in air temperatures. The greenhouse effect is also causing climatic changes. Wind patterns are changing and as a result, the cloud movements and the locations where the rain falls are changing causing ere the rain falls are changing, causing

drought and floods in new locations. Higher tem peratures are causing the ocean levels to rise. Acid rains are causing acidification of lakes, rivers, and estuaries, with loss of aquatic life. They are also causing desertification, deforestation, and corrosion of structures. (See W91-11067 thru W91-11085) (Brunone-PTT) W91-11066

ATMOSPHERIC CARBON DIOXIDE AND THE GLOBAL CARBON CYCLE: THE KEY

Oak Ridge National Lab., TN. Environmental Sci-

T. H. Peng, W. M. Post, D. L. DeAngelis, V. H. Dale, and M. P. Farrell.

Date, and M. P. Partell.

IN: Environmental Problems and Solutions:
Greenhouse Effect, Acid Rain, Pollution. Hemisphere Publishing Corporation, New York. 1990. p
17-38. 1 fig. 2 tab, 56 ref. US DOE Contract DEAC05-840R2140.

Descriptors: \*Air pollution, \*Atmospheric chemistry, \*Carbon cycle, \*Carbon dioxide, \*Mathematical models, \*Model studies, \*Path of pollutants, Anthropogenic effects, Biogeochemistry, Estimating, Marine environment, Organic carbon, Uncertainty.

The biogeochemical cycling of carbon determin the rate of increase in atmospheric carbon dioxide concentrations. The observed increase is less than the estimated release from fossil fuel consumption and deforestation. This discrepancy can be ex-plained by interactions between the atmosphere and other global carbon reservoirs such as the oceans, and the terrestrial biosphere, including soils. Results from studies of past fluctuations in atmospheric carbon dioxide and climate suggest that current carbon cycle models that emphasize human disturbances may overlook natural feedback components involving both terrestrial and marine systems. Because of current uncertainties in marine systems. Because of current uncertainties in atmospheric carbon dioxide fluctuations over the last 200 years, the contribution of non-fossil carbon sources cannot be satisfactorily explained. The physical, chemical and biological processes of carbon dioxide uptake can probably only come from mathematical models. Unfortunately, one-dimensional and two-dimensional ocean models do not allow for enough carbon dioxide uptake to accurately account for known releases. More complex three-dimensional models may make better use of existing tracer data than do one-dimensional and two-dimensional and will also incorporate cliand two-dimensional and will also incorporate cli-matic feedback effects to provide a more realistic view of ocean dynamics and carbon fluxes. In describing the various carbon dioxide exchanges between the atmosphere and terrestrial syster estimates of the net release of carbon to the atm phere from deforestation are incompatible with ocean model carbon dioxide uptake. Furthermore, the estimated loss rate of terrestrial organic carbon from biota and soils is so small compared to the total mass of organic carbon that these losses are largely undetectable and can only be estimated indirectly from models. Approaches must be adopted that emphasize both data and model improvements, keying in on critical uncertainties, and addressing areas where no easy solutions exist or where knowledge is needed. (See also W91-11066) (Author's abstract) W91-11068

UNCERTAINTY IN THE PROJECTION OF CARBON DIOXIDE EMISSIONS.

Yale Univ., New Haven, CT. Dept. of Economics. G. W. Yohe.

In: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemi-sphere Publishing Corporation, New York. 1990. p 39-60. 2 fig. 9 tab, 58 ref.

Descriptors: \*Air pollution sources, \*Carbon dioxide, \*Energy sources, \*Mathematical models, \*Model studies, \*Uncertainty, Carbon cycle, Estimating, Fuel, Future planning, Human population, Prediction, Productivity, Statistical analysis.

### Group 5B-Sources Of Pollution

Present knowledge about future carbon concentraresent knowledge about ruture carroot concentrations in the atmosphere is extremely imprecise. Doubling appears most likely around the year 2070, but a significant probability (22%) exists, on the basis of current information, that doubling will occur before the year 2050. The three major sources of uncertainty that emerge are (1) the rate of productivity growth, (2) the elasticity of substitutions of the productivity growth, (2) the elasticity of substitutions are the productivity growth, (2) the elasticity of substitutions are the productivity growth, (2) the elasticity of substitutions are the productivity growth, (2) the elasticity of substitutions are the productivity growth. tution of energy sources, and (3) the bias in energy-based technological change towards nonfossil fuel Extrapolative models are essentially one-equation global models, with three key variables: total resources of carbon-based fuels, initial growth rate, and a qualitative judgement about the future pat-tern of resource exploitation. Results of models showed that (1) the doubling of carbon dioxide concentrations in the atmosphere is predicted to occur later than has been previously suggested; (2) productivity growth and future trends in technology affecting noncarbon-based fuels relative to gy affecting noncarbon-based fuels relative to carbon-based fuels are the most important areas of uncertainty affecting future carbon dioxide concentrations; and (3) population growth and world resources of carbon-based fuel account for 11% of the variance in emissions projected for the year 2100. (See also W91-11066) (Brunone-PTT) W91-11069

AMBIENT AIR CO-MODELING IN ALASKA. Alaska Univ., Fairbanks. School of Engineering. For primary bibliographic entry see Field 7C. W91-11070

EFFECTS OF LAND USE ALTERATION ON TROPICAL CARBON EXCHANGE. Butler Univ., Indianapolis, IN. Holcomb Research

For primary bibliographic entry see Field 4C. W91-11072

ACID PRECIPITATION: A REVIEW.
Dow Chemical U.S.A., Midland, MI. Dept. of
Environmental Quality.

U. M. Cowgill. In: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemisphere Publishing Corporation, New York. 1990. p sphere Publishin 111-137, 160 ref.

Descriptors: \*Acid rain, \*Acid rain effects, \*Liter-ature review, \*Path of pollutants, \*Water pollution sources, Attitudes, Fuel, Hydrogen ion concentra-tion, Land use, Legislation, Nitric acid, Nitrogen, Precipitation, Sulfur, Sulfuric acid.

Acid precipitation philosophies are divided into two groups. Group I holds the view that this environmental problem requires legislative attention, that such precipitation results chiefly from the combustion of fossil fuels which release oxides of N and S into the atmosphere. Once present, N and S may undergo transformation to their respective acids and these substances may be transported great distances. Once deposited, these acids cause damage not only to all components of the natural landscape, but also to statues, monuments, builddamage not only to an components of the natural landscape, but also to statues, monuments, buildings and other anthropogenic materials. In addition, this group has the opinion that this phenomena has persisted since the mid-1950's; that the problem has worsened and the area affected is proneem has worsened and the area affected is steadily expanding. Proponents of Group I present data illustrating a mean decline of 0.5 pH units below the norm for rain (pH 5.6) in the regions affected. Group II offers several alternative expla-nations for the reported and sometimes observed phenomena. They suggest that acid conditions nations for the reported and sometimes observed phenomena. They suggest that acid conditions noted in water bodies result from drastic changes in land use, that reexamination of historical data reveal these data to be trendless, that local and natural sources of N and S oxides, especially resulting from the combustion of oil, play a major role in the feet of the state of the stat the formation of acidic precipitation in the region at risk. Finally, Group II attests that quantitatively attributing the phenomena of acid rain falling in one place to its origin in another place is difficult. Meteorological physiological, biological aspects of meteorological physiological, nological aspects of acid precipitation are reviewed from these two points of view, with emphasis on the known and the unknown in this complicated area of research. (See also W91-11066) (Author's abstract)

W91-11074

CHEMICAL COMPOSITION OF INDIVIDUAL STORMS AS A FUNCTION OF AIR PARCEL TRAJECTORIES FOR THE PREDICTION OF ACID RAIN CHARACTERISTICS.
British Columbia Ministry of Environment, Victo-

ria. Waste Management Branch. M. S. Kotturi.

In: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemi-sphere Publishing Corporation, New York. 1990. p 139-148. 3 fig. 7 tab, 5 ref.

Descriptors: \*Acid rain, \*Air pollution sources, \*Atmospheric chemistry, \*Chemistry of precipitation, \*Storms, British Columbia, Canada, Hydrogen fluoride, Hydrogen ion concentration, Path of pollutants, Rainfall, Sulfur dioxide.

The effects of local industrial emissions on pretation chemistry were tested in northwestern British Columbia. In the study area, in addition to general precursors to acid rain like sulfur dioxide (16 tons/day), the presence of hydrogen fluoride (2.18 tons fluoride/day) presents a unique situation in western Canada. To assess the impact of sulfur dioxide and hydrogen fluoride emissions on pH, event precipitation samples were collected and analyzed. The data showed that the fluoride concentration in ambient air decreased with increased precipitation. The acidity and fluoride concentra-tion in rain were higher in the summer than in other seasons, and the fluoride wet deposition rate was at a minimum in summer due to the heavy rainfall. Furthermore, the comparison of storm trajectories with observed ionic loading has offered an opportunity to qualitatively assess pollution re-ceived by rain water during storms from local individual industrial sources as well as distant natural and other sources. (See also W91-11066) (Author's abstract) W91-11075

UTILITY PLANNING MODEL FOR THE STUDY OF AIR POLLUTION REDUCTION. Carnegie-Mellon Univ., Pittsburgh, PA. Center for Energy and Environmental Studies. primary bibliographic entry see Field 5G. W91-11079

RELATIONSHIP OF REGIONAL WATER QUALITY TO AQUIFER THERMAL ENERGY

Battelle Pacific Northwest Labs., Richland, WA. For primary bibliographic entry see Field 5C. W91-11082

COMPARATIVE PHYSICO-CHEMICAL ANALYSIS OF DRINKING, GROUND AND INDUSTRIAL WASTE WATER OF JODHPUR.

Jodhpur Univ. (India). Dept. of Chemistry. R. C. Kapoor, J. Kishan, K. C. K. Mathur, P. Sharma, and M. Mathur.

IN: Environmental Problems and Solutions: In: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemi-sphere Publishing Corporation, New York. 1990. p 437-446. 2 fig. 3 tab, 15 ref. Department of Science and Technology Grant HCS/DST/533/78.

Descriptors: \*Drinking water, \*Groundwater pol-Descriptors: "Drinking water, "Groundwater pol-lution, "India, "Industrial wastewater, "Jodhpur, "Path of pollutants, "Wastewater pollution, "Water chemistry, "Water pollution sources, "Water quality monitoring, Cadmium, Chemical oxygen demand, Copper, Lead, Toxicity, Trace metals, Water quality trends, Zinc.

The presence of various pollutants has been monitored in drinking and groundwater in Jodhpur, tored in drinking and groundwater in Jodhpur, India. The waste water is slowly influencing the quality of the groundwater, which is a major source of the city's drinking water supply. Inorganic constituents, such as alkalinity, hardness, sulfate, phosphate, chloride, fluoride, dissolved oxygen, and iron have been estimated. Trace levels of cadmium, copper, lead and zinc have been measured using differential pulse polarography and differential pulse anodic stripping voltammetry. The

chemical oxygen demand has been used to measure chemical oxygen demand has been used to measure the degree of organic pollution strength in sewage and industrial waste water. The industrial waste water is highly toxic in nature, possessing a deep color (dark-red purple) accompanied by a foul smell. No aquatic life or vegetation is visible near the banks of the open drains in which the industrial effluent flows. The effluent has higher alkalinity, chloride and dissolved solid levels then permissible. The concentration of metal ions is within permissible limits, but phosphate is in excess. The untreated effluents of various industries pose a great risks to the environment of this area, by polluting the area in which they drain. (See also polluting the area in which they drain. (See also W91-11066) (Brunone-PTT) W91-11083

ESTIMATION OF TRACE METALS LEVELS IN POWER AND INDUSTRIAL WASTE WATER OF JODHPUR BY DIFFERENTIAL ANODIC STRIPPING PULSE

Jodhpur Univ. (India). For primary bibliographic entry see Field 5A. W91-11084

ENERGY TRANSFORMATION-ECOLOGY INTERFACE FROM A NONLINEAR, NONE-QUILIBRIUM THERMODYNAMIC PERSPEC-

George Washington Univ., Washington, DC. Dept. of Civil, Mechanical, and Environmental Engineering. A. A. Oni.

In: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemi-sphere Publishing Corporation, New York. 1990. p 457-466. 17 ref.

Descriptors: \*Ecosystems, \*Energy transfer, \*Environmental effects, \*Equilibrium, \*Model studies, \*Path of pollutants, \*Thermodynamics, Fuel, Future planning, Powerplants, Prediction, Theoretical analysis, Water quality monitoring, Water resources management.

Non-linear, non-equilibrium thermodynamic methods are applicable to energy-ecology systems in general. Certain energy transformation-ecology interactions, involving the reactions of certain biotic variables to the various effects of power plant-generated air and aquatic pollution, are evaluated along a non-equilibration thermodynamic analogic path on the basis that the energy transformation-ecology interface constitutes a non-equilibrium anisotropic, open system in which irreversible tion-ecology interface constitutes a non-equilibrium, anisotropic, open system in which irreversible processes occur. A new formalism quantifies environmental quality on the basis of these irreversible processes, through the development of an explicit phenomenological scheme that relates those ecological phenomena to the energy transformation-ecology interface. A theoretical evaluation of the ecology interface. A theoretical evaluation of the quality of a typical ecosystem that includes a fossil fuel-electricity transforming power plant is conducted by means of the application of this formalism. A quality index, the Entropic Lump Index (ELD), is developed. The potential advantages of an exploratory approach include the ability to compare the quality of two environments and the comparative contributions to this quality by different types of plants. The approach would be perceived as supplementary to current environmental quality quantification methods. Also, opportunities exist for evaluating the cost-effectiveness of environmental quality improvement schemes by evaluating the incremental costs of each percentage ating the incremental costs of each percentage reduction in ELI. Finally, the index could indeed be utilized to prioritize allocation of monetary resources for environmental quality improvement. (See also W91-11066) (Brunone-PTT) W91-11085

ASSESSMENT OF HYDROGEOLOGIC CONDITIONS WITH EMPHASIS ON WATER QUALITY AND WASTEWATER INJECTION, SOUTHWEST SARASOTA AND WEST CHARLOTTE COUNTIES, FLORIDA.

Geological Survey, Tallahassee, FL. Water Resources Div.

### Sources Of Pollution—Group 5B

For primary bibliographic entry see Field 2F. W91-11087

GEOPHYSICAL AND CHEMICAL INVESTIGATIONS OF GROUND WATER AT FIVE INDUSTRIAL OR WASTE-DISPOSAL SITES IN
LOGAN TOWNSHIP, GLOUCESTER COUNTY,
NEW JERSEY, 1983-87.
Geological Survey, West Trenton, NJ.
J. Kzonski, P. J. Lacombe, J. J. Hochreiter, and J.
C. Lewis.
Available from Beaks and One Tille Re-

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4004, 1990. 131p, 14 fig, 9 tab, 86 ref, 5 append.

Descriptors: "Geophysics, "Groundwater pollution, "New Jersey, "Path of pollutants, "Waste disposal, "Water pollution sources, Aquifers, Benzene, Bicarbonates, Calcium, Conductivity, Displayed salids, Groundwater quality, Heavy metals, solved solids, Groundwater quality, Heavy metals, Iron, Manganese, Organic compounds, Regula-tions, Salinity, Sodium.

Five former or active industrial or waste disposal sites in Logan Township were identified by the Federal government and by the State of New Jersey as potential threats to the quality of groundwater there. The sites are: (1) Air Products and Chemicals, Inc. waste disposal site; (2) Bridgeport Rental and Oil Services, Inc.; (3) Chemical Leaman Tank Lines, Inc.; (4) Monsanto Company; and (5) Rollins Environmental Services, Inc. Shallow (<50 ft below land surface) ionic groundwater contamination at the waste disposal sites was delineated by electromagnetic conductivity. Quality of groundwater was determined by chemical ity of groundwater was determined by chemical analysis of samples from wells at four of the five sites and elsewhere in the township. Groundwater in the lower aquifer of the Potomac-Raritan-Magin the lower adjunter of the Potomac-Rantan-Mag-othy aquifer system in Logan Township and sur-rounding areas is dominated by sodium and chlo-ride ions and is slightly saline (1,000 to 3,000 mg/L dissolved solids). Calcium, sodium, and bicarbon-ate are the predominant ions in the upper and middle aquifers; the concentration of dissolved solids is low (< 1,000 mg/L). Concentrations of iron and manganese in the groundwater range from 6 to 73,000 microgm/L, and from 33 to 1,100 trom 6 to 73,000 microgm/L, and from 35 to 1,100 microgm/L. Concentrations of organic carbon range from 0.60 to 4.2 mg/L. Areas of high apparent conductivity (> 15 millisiemens/M) were detected east of the waste oil lagoon at the Bridgeport Rental and Oil Services, Inc. site. Inorganic groundwater contamination at the site is characterized by concentrations of cadmium and lead that exceed Federal and State primary drinking water regulations (10 and 15 microgm/L). Groundwater at the Chemical Learnan site also is characterized by elevated concentrations of organic nitrogen, and concentrations of As, Cr, Pb, and Hg that exceed Federal primary drinking water regula-tions. Concentrations of dissolved solids ranged from 339 to 3,530 mg/L at the Monsanto Site and typically are much higher than background levels, but the cause is unclear. (Lantz-PTT)

PRELIMINARY DATA SUMMARY FOR IN-DUSTRIAL LAUNDRIES. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-126541. Price codes: A09 in paper copy, A01 in microfiche. Report No. EPA 440/1-89/103, September 1989. 180p, 14 fig, 48 tab, 39 ref. EPA Contract Nos. 68-03-6302, 68-03-3545, and 68-03-3339.

Descriptors: \*Economic aspects, \*Environmental impact, \*Industrial wastewater, \*Laundering, \*Water pollution effects, \*Water pollution sources, Aquatic environment, Arsenic, Benzidine, Lead, Wastewater treatment, Zinc.

The US EPA has conducted a study of the industrial laundries industry in response to a recommendation made in the Domestic Sewage Study and because of concern for the potential discharge of toxic and hazardous pollutants. Industrial laundries (SIC 7218) are primarily engaged in supplying laundered or, to a limited extent, dry-cleaned work uniforms, wiping towels, safety equipment (gloves,

flame-resistant clothing), dust covers and cloths, and similar items to industrial or commercial users. Samples of raw wastewater, and treated final efflu-ent at laundries with wastewater treatment facilities, and waste solids were collected and analyzed for a wide variety of hazardous and nonhazardous pollutants. The results of the analyses showed that any of a large number of hazardous organic or metallic pollutants may be found in industrial laundry wastes at metallic pollutants may be found in industrial laundry wastes at concentrations that vary widely with location and time. Some hazardvary widely with location and time. Some hazard-ous pollutants were found at levels above 10 mg/ L. BOD5, total suspended solids, and oil and grease levels average approximately 1000 mg/L. Economic data characterizing the industrial laun-dries industry were compiled, and indicated that the number and size of industrial laundries and the number of employees and the revenues generated per facility were determined. The study showed per facility were determined. The study snowed that the industry comprises many rather small facilities and a few large ones which economically dominate the industry. There has been some growth in the industry in some regions of the country but overall there has been little growth country but overall there has been little growth. country but overall there has been little growth either in number of employees or revenue in the last twenty years. Three major influences on the industry are shown to be competition within an industry experiencing no significant growth, the availability of substitute goods and services, and availability of substitute goods and services, and environmental regulation. An environmental impact study evaluated the impacts of fourteen indirect discharging industrial laundries on public-ly owned treatment works (POTWs) and ultimately owned treatment works (POI Ws) and ultimate-ly on the POTW receiving streams. Two data sets were used for the environmental impact analysis, one from a 1986-1987 EPA industrial laundries wastewater effluent monitoring program and one from a similar 1978 EPA program. Only benzidine and arsenie exceed human health criteria and cya-nide exceeds chronic aquatic life criteria. Analysis of the 1978 data set projects water quality impacts. Six pollutants exceed human health criteria or chronic aquatic life criteria or both, and two pol-lutants (zinc and lead) exceed POTW inhibition levels. (Lantz-PTT) W91-11093

TECHNIQUES FOR ESTIMATION OF STORM-RUNOFF LOADS, VOLUMES, AND SELECTED CONSTITUENT CONCENTRATIONS IN URBAN WATERSHEDS IN THE UNITED STATES.

Geological Survey, Lakewood, CO. Water Re-

s Div.

N. E. Driver, and G. D. Tasker. Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Supply Paper 2363, 1990. 44p, 6 fig. 12 tab, 45 ref.

Descriptors: \*Model studies, \*Nonpoint pollution sources, \*Pollutant load, \*Statistical models, \*Storm runoff, \*Urban hydrology, \*Urban runoff, Ammonia, Data interpretation, Dissolved solids, Drainage, Land use, Nitrogen, Rainfall-runoff relationships, Regression analysis, Seasonal variation, Statistical methods, Urban areas.

Urban planners and managers need information on the quantity of precipitation and the quality and quantity of runoff in their cities and towns if they quantity of runoff in their cities and towns it they are to adequately plan for the effects of storm runoff from urban areas. As a result of this need, four sets of linear regression models were devel-oped for estimating storm runoff constituent loads, storm runoff volumes, storm runoff mean concen-trations of constituents, and mean seasonal or mean annual constituent loads from physical, land use, annual constituent loads from physical, and user, and climatic characteristics of urban watersheds in the United States. Thirty-four regression models of storm runoff constituent loads and storm runoff volumes were developed, and 31 models of storm runoff mean concentrations were developed. Ten models of mean seasonal or mean annual constitumodels of mean seasonal or mean annual constitu-ent loads were developed by analyzing long-term storm rainfall records using at-site linear regression models. Three statistically different regions, delin-eated on the basis of mean annual rainfall, were used to improve linear regression models where adequate data were available. Multiple regression analyses, including ordinary least squares and gen-

eralized least squares, were used to determine the optimum linear regression models. These models can be used to estimate storm runoff constituent loads, storm runoff volumes, storm runoff mean concentrations of constituents, and mean seasonal or mean annual constituent loads at gaged and ungaged urban watersheds. The most significant explanatory variables in all linear regression models were total storm rainfall and total contributing drainage area. Impervious area, land use, and mean annual climatic characteristics also were sigmean annual characteristics also were sig-inficant in some models. Models for estimating loads of dissolved solids, total nitrogen, and total ammonia plus organic nitrogen as nitrogen generally were the most accurate, whereas models for suspended solids were the least accurate. The most accurate models were those for application in the more arid Western States, and the least accurate models were those for areas that had large mean annual rainfall. (Author's abstract) W91-11094

NONPOINT SOURCES: AGENDA FOR THE FITURE.

Environmental Protection Agency, Washington, DC. Office of Water Supply.

For primary bibliographic entry see Field 6E. W91-11098

CALIBRATION OF A TEXTURE-BASED MODEL OF A GROUND-WATER FLOW SYSTEM, WESTERN SAN JOAQUIN VALLEY, CALIFORNIA.

Geological Survey, Sacramento, CA. Water Reces Div.

S. P. Phillips, and K. Belitz.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 90-573, 1990. 30p, 13 fig, 2 tab. 30 ref.

Descriptors: \*California, \*Groundwater move-ment, \*Groundwater pollution, \*Model studies, \*Path of pollutants, \*San Joaquin Valley, \*Selenium, \*Soil texture, Hydraulic conductivity, Mathematical models, Sediment analysis, Soil water, Statistical analysis.

The occurrence of selenium in agricultural drain water from the western San Joaquin Valley, California, has focused concern on the semiconfined groundwater flow system, which is underlain by the Corcoran Clay member of the Tulare Formation. A two-step procedure is used to calibrate a reliminary model of the system for the purpose of determining the steady-state hydraulic properties are modeled as functions of the percentage of coarse sediment, hydraulic conductivities or coarse-texture (K-carse) and fine-textured (K-fine) end members, and averaging methods used to calculate equivalent hydraulic conductivities. The vertical conductivity of the Corcoran (K-corc) is calculate equivalent hydraulic conductivities. The vertical conductivity of the Corcoran (K-corc) is an additional parameter to be evaluated. In the first step of the calibration procedure, the model is run by systematically varying the following variables: (1) K-coarse/K-fine, (2) K-coarse/K-corc, and (3) choice of averaging methods in the horizontal and vertical directions. Root mean square error and bias values calculated from the model results are functions of these variables. These measures of interesting the amendation of the companion of the control of the contro functions of these variables. These measures of error provide a means for evaluating model sensitivity and for selecting values of K-coarse, K-fine, and K-core for use in the second step of the calibration procedure. In the second step, recharge rates are evaluated as functions of K-coarse, K-core, and a combination of averaging methods. The associated K-fine values are selected so that the root mean square error is minimized on the basis of the results from the first step. The results of the two-step procedure indicate that the spatial distribution of hydraulic conductivity that best produces the measured hydraulic head distribution is created through the use of arithmetic averaging in the horizontal direction and either geometric or is created through the use of antimetic averaging in the horizontal direction and either geometric or harmonic averaging in the vertical. The equivalent hydraulic conductivities resulting from either combination of averaging methods compare favorably to field-based and laboratory-based values. (Author's abstract)

### Group 5B-Sources Of Pollution

W91-11101

BIODEGRADATION OF CHEMICALS AT TRACE CONCENTRATIONS. Cornell Univ., Ithaca, NY

M. Alexander.

M. Alexander.
Available from the National Technical Information
Service, Springfield, VA. 22161, as AD/A212 409.
Price codes: A03 in paper copy, A01 in microfiche.
Final Report, June 30, 1989. 27p. 17 ref. Amy
Research Office Grant No. DAALO3-86-K-00779.

Descriptors: \*Bioassay, \*Biodegradation, \*Biological studies, \*Fate of pollutants, \*Microbial degradation, \*Organic compounds, \*Path of pollutants, Corynebacterium, Dichlorophenoxyacetate, Microbiological studies, Nitrophenols, Phenols, Pseu-

Toxic waste sites contain from a few to a wide range of organic compounds. Many of these chemicals are at concentrations that may inhibit the biodegradation of others. Moreover, because of the frequent diversity of compounds present, their biodegradation probably involves the activities of several microbial species. In environments in which several synthetic organic chemicals are present, the biodegradation of one or more may be inhibited by the presence of others. In addition to the interspecific interaction in which one population, two or more species may interact if the inhibitory synthetics initially present, or those generated by microorganisms. are microbiologically dethe biodegradation of others. Moreover, because of by microorganisms, are microbiologically de-stroyed so that sensitive organisms may effect the biodegradation of substrates they otherwise might not be able to destroy. Therefore, a study was designed to determine the interactions that might occur when two chemicals (p-nitrophenol and 2,4 dichlorophenoxyacetate) at concentrations inhibitory to microorganisms are provided together to two bacteria (corynebacterium and pseudomonas) each of which can use one of the compounds. The factors determined to be of importance to these transformations and to proposed bioremediation actions were protozoan predation, inorganic nutrient supply, concentration of the test organic compound, the presence of inhibitors and alternative sources of biodegradable molecules, and the sorption and water solubility of the toxicants. (Lantz-PTT) W91-11102

TRANSPORT AND FATE OF ACETONE IN AN OUTDOOR MODEL STREAM, STENNIS SPACE CENTER NEAR BAY ST. LOUIS, MIS-

Geological Survey, Denver, CO. Water Resources

R. E. Rathbun, D. J. Shultz, D. W. Stephens, and

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4141, 1989. 101p, 38 fig, 29 tab, 65 ref.

Descriptors: \*Acetone, \*Alcohols, \*Fate of pollutants, \*Model studies, \*Path of pollutants, Bacteria, Bay St Louis, Detritus, Flow velocity, Glucose, Mississippi, Nitrogen, Phosphorus, Volatilization.

Acetone, rhodamine-WT dye, t-butyl alcohol, and glucose were modeled in an outdoor stream to determine their fate and transportation in the system. Acetone was injected continuously for 32 days, resulting in concentrations in the 20 to 200 mg/L range in the stream water. Rhodamine-WT mg/L range in the stream water. Modamine-Wi dye was injected at the beginning and at the end of the experiment to determine the dispersion and traveltime characteristics of the stream. An injec-tion of t-butyl alcohol was used to determine the volatilization characteristics of the stream. A glu-cose solution was injected from day 17 through day 20 of the experiment in an attempt to stimulate the growth of bacteria in the stream water, with subsequent bacterial degradation of the acetone. Similarly, a nutrient solution containing bacteria acclimated to acetone in the laboratory was injected on days 23 and 24 in an attempt to stimulate the bacterial degradation of acetone. A diel oxygen study was conducted on days 11 and 12 of the

experiment to determine the productivity of the model stream. Conclusions resulting from this study are: (1) nitrogen/phosphorus ratios in the model stream were small relative to values from the literature considered desirable for efficient bacterial degradation of organic compounds; (2) the model stream was biologically rich and the bottom of the stream cross section contained a layer of organic detritus; (3) the mean residence time in the model stream, as determined from the dye studies was about 6 hrs; (4) mean water velocities and longitudinal dispersion coefficients determined in iongrudinal dispersion coefficients determined in the preliminary dye study and twice during the acetone-injection experiment generally were in good agreement. Mean velocities ranged from 0.317 m/min to 0.588 m/min and dispersion coeffi-cients from 0.300 sq m/min to 5.35 sq m/min for the different reaches of the stream; (5) volatilizathe different reaches of the stream; (3) Volanifiza-tion coefficients for acctone were in good agree-ment, with the exception of the day 4 values which, for the most part, were larger; (6) injection of a glucose solution resulted in no significant decrease in acctone concentrations in the model stream; (7) injection of the nutrient solution containing bacteria acclimated to acetone in the laboratory resulted in no apparent decrease in the acetone concentrations in the model stream. acetone concentrations (Lantz-PTT)

EXECUTIVE SUMMARY—ASSESSING THE RESPONSE OF EMERALD LAKE, AN ALPINE WATERSHED IN SEQUOIA NATIONAL PARK, CALIFORNIA, TO ACIDIFICATION DURING SNOWMELT USING A SIMPLE HYDROCHEMICAL MODEL.

Geological Survey, Doraville, GA. Water Resources Div. For primary bibliographic entry see Field 7C. W91-11112

PATHWAY ANALYSIS OF SELECTED OR-GANIC CHEMICALS FROM SEWAGE TO AG-RICULTURAL SOIL. Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Due-bendorf (Switzerland).

H. Siegrist, A. Alder, P. H. Brunner, and W.

IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environ-mental Effects. Elsevier Science Publishing Co., New York. 1989. p 133-144. 4 fig, 7 tab, 19 ref.

Descriptors: \*Organic pollutants, \*Path of pollutants, \*Sludge, \*Sludge disposal, \*Sludge treatment, \*Switzerland, \*Wastewater treatment, Aerobic digestion, Agriculture, Degradation, Environmental effects, Linear alkyl sulfonates, Nonylphenolethox-

The organic xenobiotic compounds are of concern in sewage sludge therefore, the behavior and fluxes of linear alkylbenzenesulphonates (LAS), and non-ylphenolethoxylates (NPnEO) and the more toxic ylphenolethoxylates (NPnEO) and the more toxic NPnEO metabolites nonylphenol (NP), nonyl-phenolmonoethoxylate (NP1EO) and nonylphenoldiethoxylate (NP2EO) were investigated in sewage and sewage sludge treatment. Most of the particuand sewage sludge treatment. Most of the raw sewage late matter of the raw matter of the raw sewage and the excess activated sludge are removed in and the excess activated sludge are removed in the primary effluent of a wastewater treatment plant and will not be further subjected to aerobic treatment. Thus, the only aerobically degradable and lipophilic compounds, such as LAS and NP, become highly enriched in sewage sludge; in 1986 4 g LAS/kg total solids (TS) and 1.2 g NP/kg TS were found. In 1988, LAS has increased 40% (5.6 c/kg TS) and NP decreased 10%, (0.3 a kg/ 1.8 g total solids). g/kg TS) and NP decreased 70% (0.33 g/g TS) due to the NPnEO-ban in 1986. Therefore several hundred tons per year are spread on agricultural soil in Switzerland. Analysis of sludge amended soil showed that LAS and NP are still detectable several months after the last sludge application, suggesting that the behavior of these compounds, and compounds with similar chemical characteristics, should be thoroughly investigated in the soil ecosystem. (See also W91-11115) (Author's abstract)

ORGANIC SUBSTANCES IN SOILS AND PLANTS AFTER INTENSIVE APPLICATIONS OF SEWAGE SLUDGE.

OF SEWAGE SEDDRE.
Landwirtschaftliche Untersuchungs- und Forschungsanstalt, Speyer (Germany, F.R.).
For primary bibliographic entry see Field 5E.
W91-11126

ENVIRONMENTAL ASPECTS OF LANDFILL-ING SLUDGE.

Rijksinstituut voor de Volksgezondheid en Milieu-hygiene, Bilthoven (Netherlands). Lab. of Waste Materials and Emissions.

For primary bibliographic entry see Field 5E.

HEAVY METAL SPECIATION IN SEWAGE SLUDGE FOLLOWING A PHYTO-DEWATER-ING TREATMENT.

Consiglio Nazionale delle Ricerche, Pisa (Italy). Consigno Nazionale delle Ricerche, Fisa (Maly). Ist. di Chimica Terreno. For primary bibliographic entry see Field 5D. W91-11147

STUDIES FOR A SIMULTANEOUS USE OF LIQUID MANURE AND SEWAGE SLUDGE. Bayerische Landesanstalt fuer Bodenkultur und Pflanzenbau, Munich (Germany, F.R.). For primary bibliographic entry see Field 5E. W91-11157

MICROBIAL BIOMASS AND BIOLOGICAL ACTIVITIES IN AN ACID SANDY SOIL TREATED WITH SEWAGE SLUDGE OR FARMYARD MANURE IN A LONG TERM FIELD EXPERIMENT.

Institut National de la Recherche Agronomique, Bordeaux (France). Station d'Agronomie. For primary bibliographic entry see Field 5E. W91-11160

AGRICHEMICALS AND GROUNDWATER PROTECTION: RESOURCES AND STRATE-GIES FOR STATE AND LOCAL MANAGE-

For primary bibliographic entry see Field 5G. W91-11162

PLANNED STUDIES OF AGRICHEMICALS IN GROUND AND SURFACE WATER IN MID-CONTINENTAL UNITED STATES.

Geological Survey, Reston, VA. S. E. Ragone, M. R. Burkart, E. M. Thurman, and

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 99-111, 3 fig, 16 ref.

Descriptors: \*Agricultural chemicals, \*Atrazine, \*Data acquisition, \*Data interpretation, \*Geographic information systems, \*Model studies, \*Nonpoint pollution sources, \*Path of pollutants, Agricultural practices, Computer models, Geohydrology, Herbicides, Pesticides, Water quality

Federal agencies are currently reviewing a planned study on the effects of agricultural practices on the occurrences of herbicides, insecticides, as well as other pesticides, and fertilizers in the mid-continen-tal United States. Atrazine was selected as the representative herbicide because of its history of extensive usage. The plan provides procedures that integrate information from a wide variety of integrate information from a wide variety of sources. A research matrix using a mass-balance concept was designed to account for the distribution of atrazine in a hydrologic system. Processes in the matrix include the major physical, chemical, and biological actions that may transform, transport, or store atrazine in the hydrologic system. This matrix will be applied at three scales: laboratory, field, and regional. Existing herbicide transport models will be used to determine the effect of individual or aggregate factors on the fate of atrazine in water. Models such as CREAMS will be

### Sources Of Pollution-Group 5B

used to evaluate the timing of pesticide movement while models such as PRZM and GLEAMS will be used to predict the importance of atrazine in the unsaturated zone. Geohydrologic information and factors relating to land use, climate, and soils will be stored in a Geographic Information System.

From these studies, regression models, multivariate. From these studies, regression models, multivariate statistical models will be developed to explain the patterns of atrazine contamination. (See also W91-11162) (Rubinstein-PTT)

APPLICATION OF THE DRASTIC MAPPING SYSTEM FOR EVALUATING GROUND WATER POLLUTION POTENTIAL IN OHIO. Ohio Dept. of Natural Resources, Columbus. Div. of Water.

R. J. Petty, and M. A. Hallfrisch.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 181-200, 6 fig, 2 tab, 4 ref, 3 map.

Descriptors: \*DRASTIC system, \*Geographic information systems, \*Groundwater pollution, formation systems, \*Groundwater pollution, \*Mapping, \*Maps, \*Nonpoint pollution sources, \*Ohio, \*Pollution index, Computer programs, Geohydrologic units, Groundwater movement, Land use, Optimization, Water use.

A pollution potential mapping program for Ohio has been developed under the direction of the Division of Water, Ohio Department of Natural Resources, using the DRASTIC mapping process. The DRASTIC system consists of two major elements the development of proceedings of the program of the pro ne DRASTIC system consists of two major ele-ments: the designation of mappable units, termed hydrogeologic settings, and the superposition of a relative rating system for pollution potential. Hy-drogeologic settings form the basis of the system and incorporate the major hydrogeologic factors which affect and control ground water movement. The factors are incorporated into a relative rank-tice and setting selection of the property of the pr ing and rating scheme to produce a DRASTIC index value that represents the relative pollution potential. Hydrogeologic settings are combined with the index to create units that can be graphi-cally displayed on maps. Demonstration mapping in Madison County, Ohio, resulted in a map with symbols and colors that illustrate areas of ground symbols and colors that linearity and a symbol water contamination vulnerability. The mapping program is being implemented on a county wide basis across the state according to specific selection criteria including availability of geologic and hydrogeologic data, groundwater usage, and land use within a county. The DRASTIC system optimizes within a county. The DRASTIC system optimizes the use of existing data to rank areas with respect to pollution potential. In Ohio, the system will be used to help direct investigations and resource expenditures and to prioritize protection, monitoring, and land use planning efforts. (See also W91-11162) (Author's abstract) W91-11178

FLORIDA'S PESTICIDE WATER QUALITY EDUCATION PROGRAM.

Florida Univ., Gainesville. Dept. of Soil Science. For primary bibliographic entry see Field 5G. W91-11202

RAINWATER AND THROUGHFALL CHEMISTRY IN A TERRE FIRME' RAIN FOREST: CENTRAL AMAZONIA.
Instituto de Pesquisas Espaciais, Sao Paulo (Brazil). Lab. de Pesquisas Atmosfericas e Oceani-

For primary bibliographic entry see Field 2B. W91-11218

BIODEGRADATION OF HYDROCARBON VAPORS IN THE UNSATURATED ZONE. Massachusetts Univ., Amherst. Dept. of Civil En-

D. W. Ostendorf, and D. H. Kampbell.
Water Resources Research WRERAQ, Vol. 27,
No. 4, p 453-462, April 1991. 6 fig, 5 tab, 43 ref.
National Center for Groundwater Research and
Oklahoma State Universities Cooperative Agreement CR812808.

Descriptors: \*Biodegradation, \*Fate of pollutants, \*Hydrocarbons, \*Path of pollutants, Aeration zone, Groundwater pollution, Michigan, Military reservations, Soil contamination, Soil water, Solute transport, Traverse City. Volatilization

The widespread disposal of pesticides, herbicides, solvents, gasoline, heating oil, creosote, transmission fluid, and other hydrocarbons in waste lagoons, agricultural runoff, landfills, spills, and buried drum sites commonly leads to subsurface repulsion. The time-averaged concentrations of hypollution. The time-averaged concentrations of hydrocarbon and oxygen vapors were measured in the unsaturated zone above the residually contaminated capillary fringe at the U.S. Coast Guard Air Station in Traverse City, Michigan. Total hydro-carbon and oxygen vapor concentrations were observed over a 13-month period. Supplementary grain size, porosity, and moisture content data support the assumption of uniform, homogeneous site geology, which, in view of the planar hydrosite geology, which, in view of the planar hydro-carbon source term, abundant oxygen, and sparse data base, is suitable for simple analytical model-ing. In the assumed absence of advection, leaching, and transience, the analysis is a straightforward balance of gaseous diffusions and biological degra-dation coupled stoichiometrically in the two react-ing constituents. Volatilization is a significant transport mechanism for hydrocarbons at Traverse City, and biodegradation presents the second City, and biodegradation prevents the escape of appreciable contamination to the atmosphere for most locations at this site. Little oxygen is expect-ed to reach the water table because of the aerobic biodegradation process in the unsaturated zone. (Author's abstract)

W91-11227

THEORETICAL STUDY OF THE SIGNIFI-CANCE OF NONEQUILIBRIUM DISSOLU-TION OF NONAQUEOUS PHASE LIQUIDS IN SUBSURFACE SYSTEMS.

Michigan Univ., Ann Arbor. Dept. of Environ-mental and Water Resources Engineering. S. E. Powers, C. O. Loureiro, L. M. Abriola, and

Water Resources Research WRERAQ, Vol. 27, No. 4, p 463-477, April 1991. 13 fig. 3 tab, 86 ref. National Institute of Environmental Health Sciences Contract P42 ES043911-01 and NSF Grant

Descriptors: \*Groundwater pollution, \*Organic compounds, \*Path of pollutants, \*Soil contamination, Flushing, Hydrologic models, Mathematical models, Nonaqueous phase liquids, Numerical analysis, Solute transport.

Spills or leaks of organic chemicals to the environ-Spins or reass of organic chemicals to the environ-ment frequently result in the contamination of sub-surface soils and groundwater. Many of these pol-lutants are only slightly miscible in water and thus may exist as virtually immiscible or nonaqueous phase liquids (NAPLs). Migration of NAPLs in subsurface systems is complex. An attempt was made to assess the potential significance of devi-ations from local equilibrium for the exchange of mass between residual NAPLs and the aqueous phase in the saturated groundwater zone. A one-dimensional convection-dispersion mass balance equation incorporating a first-order interphase mass transfer rate relationship and temporal changes in blob configuration, was used to model this system. Analytical and numerical methods uns system. Analytical and numerical methods were employed to examine the steady state and transient behavior of the system under a variety of hypothetical aquifer conditions and pumping remediation schemes. Sensitivity of the model to several parameters, including mass transfer coefficient, blob size and shape, and Darcy velocity was explored. Results of this theoretical assessment indicate that nopeculibrium effects could alway a significant that no control the significant could be a significant to the control of the significant could be a significant to the significant control of the significant contro cate that nonequilibrium effects could play a significant role in some contamination scenarios, primarily for large blob sizes and relatively high ties. Design of soil flushing techniques will be impacted by these conclusions. Uncertainty in several parameter values used in this analysis indicate the need for further experimental investigation of this process. (Author's abstract)

SUBICE LAYERING AND ORIGIN OF ACIDIC WATERS IN A SMALL BOREAL LAKE DURING THE SPRING RUNOFF.

Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).

J. Roberge, and H. G. Jones. Water Resources Research WRERAQ, Vol. 27, No. 4, p 479-492, April 1991. 12 fig, 24 ref.

Descriptors: \*Acid rain, \*Acidification, \*Ice cover, \*Lake ice, \*Lakes, \*Quebec, \*Seasonal distribution, Conductivity, Forested watersheds, Hydrogen ion concentration, Lac Laflamme, Lake acidification, Rhodamine, Snowmelt, Stratification, Temperature, Tracers, Water circulation, Water

Lake ice cover is a physical barrier that limits lakeatmosphere interactions. In a small boreal forest lake (Lac Laflamme, Quebec), the subice circula-tion of waters from five distinct origins (lake premelt water, lakeshore snowpack meltwater, ice cover meltwater, groundwater, and hillslope throughflow water) was studied during the spring melt period. A network of collared access holes was used to monitor the temperature, conductivity, and pH profiles of the water column beneath the ice cover. The study also included the tracing of snowbank meltwaters and through-flow waters with rhodamine. Conductivity and pH appeared to be efficient parameters for discriminating most of the water types considered. During the spring melt three distinct low-pH episodes were recorded in the lake outflow. The first episode (pH 5) occurred in the early melt period; snow and ice meltwaters layered beneath the ice forming a stratum approximately 20 cm thick. It moved toward the outlet under laminar flow conditions (observed velocity 1 m/hr). Two subsequent pH episodes of pH 5.3 and m/hr). Two subsequent pH episodes of pH 5.3 and 5.1 were observed during the massive melt period. These episodes were due to peak flows of hillslope throughflow, which entered the lake and formed a layer 20-40 cm thick in the water column (observed water velocity greater than 20 m/hr). The ice cover thus not only modified the nearshore water quality by inducing thermal layering, but strongly influenced the quality of the outflow waters due to the segregation and rapid evacuation of the throughflow and surface meltwaters. (Author's abstract) thor's abstract) W91-11229

GEOSTATISTICAL CHARACTERISTICS OF THE BORDEN AQUIFER.
Manitoba Univ., Winnipeg. Dept. of Geological

Engineering. For primary bibliographic entry see Field 2F.

APPLICATION OF A MULTIPROCESS NONE-QUILIBRIUM SORPTION MODEL TO SOLUTE TRANSPORT IN A STRATIFIED POROUS MEDIUM.

Arizona Univ., Tucson. Dept. of Soil and Water

M. L. Brusseau. Water Resources Research WRERAQ, Vol. 27, No. 4, p 589-595, April 1991. 4 fig, 30 ref.

Descriptors: \*Groundwater movement. \*Matheordunavaer invocated, water matter matter matter models, "Model studies, "Path of pollutants, "Porous media, "Solute transport, Mass transfer, Multiprocess nonequilibrium model, Performance evaluation. Sorption

To reduce the complexity involved in analyzing solute transport, simplifying assumptions are employed. To work, these assumptions rely on the existence of 'ideal' transport. In real situations, however, 'nonideal' transport often occurs. An investigation was conducted of the capability of a model that explicitly accounts for multiple sources of nonequilibrium, to predict the transport of a nonequilibrium sorption-constrained solute in a instratified porous medium. Microaquifer experiments reported in the literature served as the source of the data that were analyzed. The best available information was used to identify values for all model input parameters, allowing the multi-process nonequilibrium (MPNE) model to be used

### Group 5B-Sources Of Pollution

in a predictive mode. The prediction obtained by the MPNE model provided a good description of the breakthrough curve obtained at a given velocithe breakthrough curve obtained at a given velocity. A breakthrough curve obtained at a slower velocity could be simulated when the apparent velocity dependence of the physical nonequilivelocity dependence of the physical nonequili-brium parameters was taken into account. Based on the reported results, the MPNE model seems to provide a valid representation of sorption dynamics and soluble transport for stratified systems in-fluenced by sorption capacity heterogeneity and multiple sources of nonequilibrium. The relative and combined impact of interlayer mass transfer, chemical nonequilibrium, and sorption capacity heterogeneity on the transport of a sorbing solute was elucidated. The MPNE has been used successfully to predict the nonideal transport of organic solutes at the field scale under both natural and induced gradients. (Author's abstract) W91-11239

STREAM CHEMISTRY IN THE EASTERN UNITED STATES: 1. SYNOPTIC SURVEY DESIGN, ACID-BASE STATUS, AND REGION-AL PATTERNS

Utah Water Research Lab., Logan.
P. R. Kaufmann, A. T. Herlihy, M. E. Mitch, and

Water Resources Research WRERAQ, Vol. 27, No. 4, p 611-627, April 1991. 9 fig, 3 tab, 69 ref. EPA Cooperative Agreements CR815168 and CR813061

Descriptors: "Acid rain, "Acid rain effects, "Acid streams, "Air pollution, "Data acquisition, "Surveys, "Water pollution sources, Acid neutralizing capacity, Aluminum, Eastern United States, Hydrogen ion concentration, Path of pollutants, Regional analysis, Spatial distribution, Sulfates, Water chemistry.

The extent and magnitude of surface water acidification caused by atmospheric pollution remains one of the most important and politically contro versial environmental issues of recent times. To assess the regional acid-base status of streams in the mid-Atlantic and southeastern United States, spring base flow chemistry was surveyed in a probability sample of 500 stream reaches representprobability sample of 500 stream reaches representing a population of 64,300 reaches (224,000 km). Approximately half of the streams had acid-neutralizing capacity (ANC) not exceeding 200 microequivalents/L. Acidic (ANC or e 0) streams were located in the highlands of the Mid-Atlantic region (southern New York to southern Virginia, 2300 km) in coastal lowlands of the Mid-Atlantic (2600 km) and in Florida (462 km). Acidic streams were rare (< 1%) in the highlands of the Southeast. Inorganic monomeric aluminum (Alim) concentrations were highest in acidic streams of the Mid-Atlantic highlands, where over 70% of the Mid-Atlantic highlands, where over 70% of the acidic streams had Alim > 100 micrograms/L, a concentration above which deleterious biological effects frequently have been reported. Dissolved organic carbon concentrations were higher in the lowland coastal streams compared with inland streams. The present data support a hypothesis that atmospheric sources and watershed retention conatmospheric sources and watershed retention con-trol regional patterns in streamwater sulfate con-centrations. Most stream watersheds retain the vast majority of the total nitrogen loading from wet deposition. The data also suggest, however, that some deposited nitrogen may be reaching streams in the Northern Appalachians. These results show that acidic surface waters are found outside the glaciated northeastern portions of the United States, and that watershed sulfate retention is not sufficient to prevent acidic conditions in some Mid-Atlantic Highlands streams. (See also W91-11242) (Author's abstract) W91-11241

STREAM CHEMISTRY IN THE EASTERN UNITED STATES: 2. CURRENT SOURCES OF ACIDITY IN ACIDIC AND LOW ACID-NEUTRALIZING CAPACITY STREAMS.

TRALIZING CAPACITY STREAMS. Utah Water Research Lab, Logan. A. T. Herlihy, P. R. Kaufmann, and M. E. Mitch. Water Resources Research WRERAQ, Vol. 27, No. 4, p 629-642, April 1991. 7 fig, 3 tab, 39 ref. EPA Cooperative Agreement CR815168.

Descriptors: \*Acid neutralizing capacity, \*Acid streams, \*Surveys, \*Water pollution sources, Acid mine drainage, Acid rain, Acidity, Air pollution, Classification, Eastern United States, Florida, Forest watersheds, Hydrogen ion concentration, National Stream Survey, New Jersey, Nitrates, Organic matter, Regional analysis, Spatial distribution, Sulfates, Water chemistry.

The U.S. EPA conducted National Stream Survey (NSS) field activities in the eastern United States in the spring of 1986 as part of the National Surface the spring of 1986 as part of the National Surface Water Survey. Anion composition in NSS data was examined to evaluate the most probable sources of current acidity in acidic and low acid-neutralizing capacity (ANC) streams in the eastern United States. Acidic streams that had almost no organic influence (< 10% of total anions) and sulfate and nitrate concentrations indicative of evaporative concentrations of atmospheric deposi-tion were classified as acidic due to acidic deposition. These acidic streams were located in small (< 30 sq km) forested watersheds in the Mid-Atlantic highlands (an estimated 1950 km of stream length) an in the Mid-Atlantic coastal plain (1250 km). Acidic streams affected primarily by acidic deposition, but influenced by naturally occurring organic anions accounted for another 1180 km of organic anions accounted to another 1760 kin of acidic stream length and were located in the New Jersey Pine Barrens, plateau tops in the Mid-Atlantic and Southeastern highlands, and the Florida panhandle. The total length of streams acidic due paniature. The total legist of site and a sacrific was about the same as the total length of acidic streams likely to be affected by acid deposition (4380 km). Acidic streams whose acid anion composition was dominated by organics were located in Florida and the Mid-Atlantic Coastal Plain. In Florida, most of the acidic streams were organic dominated, whereas about half of the streams in the Mid-Atlantic Coastal Plain were organic dominated. Organicdominated acidic streams were not observed in the Mid-Atlantic and Southeast highlands. (See also W91-11241) (Author's abstract)

AIR QUALITY AND DEPOSITION OF TRACE ELEMENTS IN THE PROVINCE OF SOUTH-HOLLAND.

Dienst Centraal Milieubecheer Rijnmond, Schiedam (Netherlands).

Atmospheric Environment ATENBP, Vol. 25A, No. 3/4, p 691-698, 1991. 2 fig, 6 tab, 23 ref.

Descriptors: \*Air pollution, \*Deposition, \*Path of pollutants, \*The Netherlands, \*Trace elements, \*Water pollution sources, Cadmium, Cobalt, Emistrol, Lead, Trace metals

The air quality of the Rijnmond area of the prov-ince of South-Holland was measured in three campaigns to study trends in the trace element deposi-tion. In campaign A, year averaged values of a number of trace elements were measured in air samples for two locations, one close to the industrialized Rijnmond area and one 35 km to the north-east in the prevailing wind direction. In campaign B, the wet deposition of trace elements was measured using wet only rain gauges. In campaign C, rain samples were collected in southwesterly winds to quantify the portion of the Rijnmond emission in the wet deposition. In addition, the levels of trace elements in moss were analyzed to investigate how far the deposition of trace elements from the Rijnmond area and from a known source to the south-east of Rotterdam is detectable. Generally the levels of trace elements found in or near Rijnmond are higher than in the rural areas, though seldom statistically significant. When the wind direction is taken into account, it is possible to assess which sources and industrial areas contribute to the meassources and industrial areas contribute to the measured concentrations in the air. Higher levels are found downwind from the Rijmmond area for As, Cd, Co, Cr, Cu, Pb, Se, Sn, V and Zn. However, when the wind comes from the southeast, markedly high levels of Co, Cr, Se, and Sn are registered coming from the Belgian and other foreign industries. The deposition velocities in the Rijmmond area are rather low when compared to values measured elsewhere. It is theorized that the high frequency of rainfall could wash out the larger

particles with the bulk of the trace elements more efficiently and suppress resuspension. Concentra-tions of trace elements in moss were elevated near a scrap smelter that was not yet equipped with adequate dust filters. After the proper filters were added, the levels of trace elements in moss decreased. (Geiger-PTT) W91-11248

SEQUENTIAL SAMPLING OF PARTICLES, MAJOR IONS AND TOTAL TRACE METALS IN WET DEPOSITION.
University of East Anglia, Norwich (England). School of Environmental Sciences.

B. Lim, D. Jickells, and T. D. Davies

Atmospheric Environment ATENBP, Vol. 25A, No. 3/4, p 745-762, 1991. 12 fig, 14 tab, 41 ref.

Descriptors: \*Acid rain, \*Chemistry of precipita-tion, \*Ireland, \*Path of pollutants, \*Trace ele-ments, \*Trace metals, \*Wet deposition, Aerosols, Painfall Aluminum, Ions, Precipitation scavenging, Rainfall intensity. Silicon.

A precipitation event was sampled at a remote. A precipitation event was sampled at a remote, coastal site at Adrigole, Ireland, during May 1988. Major ions (Cl-, NO3-, SO4--, H+, Na+, K+, Ca++, Mg++) showed a rapid decrease in concentration with time, with the exception of emmonium and non-sea salt sulfate. Elements of marine origin (Cl-, SO4--, Na+, K+, Ca++ and Mg++) were positively correlated with each other (r = 0.97-1.00) but weakly correlated with each other transity. Total traces metal concentrations. rainfall intensity. Total trace metal concentrations (Al, Cd, Pb, Mn, Fe, Cu and Zn) decreased less rapidly than major ions. Single particle characterization of the insoluble matter identified Al and Si as the dominant elements and 0.2-0.4 microns diameter as the median size range. Selective removal mechanisms of aerosols associated with minor and major elements include removal by below cloud processes and scavenging by within cloud mechanisms. (Author's abstract)

MAJOR IONS IN MARINE RAINWATER WITH ATTENTION TO SOURCES OF ALKA-LINE AND ACIDIC SPECIES,

Paris-7 Univ. (France). Lab. de Physico-Chimie de l'Atmosphere

R. Losno, G. Bergametti, P. Carlier, and G.

Atmospheric Environment ATENBP, Vol. 25A, No. 3/4, p 763-770, 1991. 5 fig, 4 tab, 12 ref.

Descriptors: \*Acid rain, \*Chemistry of precipita-tion, \*Ion transport, \*Ions, \*Path of pollutants, \*Water pollution sources, Air masses, Calcite, Hy-drogen ion concentration, Neutralization, Nitric acid. Salts. Sulfuric acid.

Rainwater was collected in ultra-clean conditions during three field experiments (two on Corsica and one during a North-South Atlantic transect of the 1988 Polarstern cruise). This rainwater was imme-1988 Polarstern cruise). This rainwater was immediately filtered and the major ions were measured by ionic chromatography, atomic absorption and colorimetric methods. In these marine areas, the concentrations of major ions range over one or two orders of magnitude and are generally dominated by the redissolution in rainwater of the sea salts. The non-sea salt component shows the presence of anthropogenic nitric and sulfuric acids which are well correlated with the origin of the air masses and which lead to acidic raise (nH from 4 masses and which lead to acidic rains (pH from 4 to 5). High values of pH (6-7) are also observed and can be explained by the neutralization of strong acids by natural alkaline dusts such as calstrong acids by natural alkaline dusts such as cal-cite, which are mainly transported from the desert areas of the African continent. A study of these variations in major ion compositions in relation to three-dimensional, air-mass trajectories demon-strates the behavior of these two components during African dust transport. (Author's abstract) W91-11250

MODELLING THE ATMOSPHERIC TRANSPORT OF TRACE METALS INCLUDING THE ROLE OF PRECIPITATING CLOUDS.

### Sources Of Pollution—Group 5B

GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). L. Levkov, D. P. Eppel, and H. Grassl. Atmospheric Environment ATENBP, Vol. 25A, No. 3/4, p 779-789, 1991. 7 fig, 31 ref.

Descriptors: \*Cloud chemistry, \*Cloud physics, \*Lead, \*Model studies, \*Path of pollutants, \*Trace metals, Aerosols, Air pollution, Mathematical models, Microphysics, Particle size, Precipitation

The wet removal of atmospheric lead was studied using a three-dimensional mesoscale model with parameterized microphysics of clouds and precipi-tation that was extended to include wet scavenging iation that was extended to include wet scavenging and deposition of trace metals from the atmosphere. Simulations were carried out in a domain of 400 sq km in the southeastern part of the North Sea including many clouds in various stages of development. The model assumes that the particles acting as host for the lead particles are cloud condensation nuclei (CCN) calculated in the model as part of aerosol particles in the air. The variation of the average concentration of aerosol particles with height as a function of size is based on data given previously. Both calculated flong range with height as a function of size is based on data given previously. Both calculated (long range transport model) and measured atmospheric monthly mean concentration of lead at the German coast of North Sea and Baltic Sea given by other researchers are used as an input pollution level by calculation of the vertical profile of the initial mean mass lead concentration in the air. The lead is accounted to be distributed uniformly to the lead. mean mass lead concentration in the air. In elean is assumed to be distributed uniformly on the aerosol particles, and the vertical profile of the initial 
mass concentration of lead in the air is assumed to 
be proportional to the vertical profile of number of 
aerosol particles as a function of size with height. 
In other words, the model deals with the fraction of lead which can enter cloud water mainly through nucleation scavenging (in-cloud scaveng-ing or rainout). The calculated concentration of ing or rainout). The calculated concentration of lead in rainwater at the first model layer (50 m above the sea surface) is in good agreement with measured weekly averages of lead deposition fluxes during precipitation events on the island of Pellworm in the vicinity of the model domain selected for validation of the numerical model. (Author's abstract) W91-11251

DISTRIBUTION AND MIGRATION OF HEAVY METALS IN THE ENVIRONMENT OF THE ALTAI MOUNTAINS IN CONNECTION WITH ECOLOGICAL SUBSTANTIATION OF THE KATUN HYDROELECTRIC STATION PROJECT.

1. L. Dmitrieva, Y. V. Zelyukova, V. S. Boldenkov, and I. V. Vezlutskaya. Hydrotechnical Construction HYCOAR, Vol. 24, No. 6, p 405-410, December 1991. 2 fig, 5 tab, 11 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, pp. 35-38, June, 1990.

Descriptors: \*Environmental impact, \*Heavy metals, \*Hydroelectric plants, \*Reservoir construction, \*Soviet Union, \*Water pollution sources, Altai Mountains, Antimony, Arsenic, Cadmium, Chromium, Copper, Fish, Katun Hydroelectric Station, Lead, Mercury, Nickel, Teletskoe Lake, Tissue analysis.

The construction of the Katun hydroelectric station in the Kuznetsk-Altai polymetallic belt (Soviet Union) has been proposed. The current content of mercury and other heavy metals in various components of the environment was examined in the Altai mountains, possible sources of entry of mercury into the Katun reservoir were determined, and the ecological risk associated with the creation of this reservoir was evaluated. The content of mercury in the waters of the Katun is 5-10 times below the maximum allowable concentration below the maximum allowable concentration (MAC = 0.5 microgram/l). Besides mercury, 23 trace elements were identified in the surface waters of the Altai Mountains. In the Katun water in the hydrostation construction reach, an excess beyond the MAC was observed for copper (1.7 MAC) and chromium (2.1-3.6 MAC). This is due to the natural background of the region. The levels of aquatic arsenic, antimony, cadmium, lead, and nickel is considerably below the MAC. The mercury con-

tent in tissues of 10 fish species of the Altai Mountains was examined (452 samples). The accumulation of the element was determined to a great extent by the fish's feeding habits, with levels for plankton feeders in the range 0.003-0.08 mg/kg, for plankton feeders 0.05-154 mg/kg, and for predators 0.07-0.254 mg/kg. An excess of the MAC was observed in several cases for predatory fishes caught in Teletskoe Lake (2% of the entire catch). The sources of entry of mercury and other heavy The sources of entry of mercury and other heavy metals into the planned reservoir are the water discharge and sediment load of the Katun, subsurface waters, and soils of the zone of flooding; some increase in the mercury concentration (not greater than the MAC) should be expected in the first 1-3 yr after filling. As the bed soils are flushed, this level will decrease. The metallogenic conditions in this area do not appear serious enough to prevent the creation of the hydrostation and reservoir. (Rochester-PTT) W91-11292

NOAA SATELLITE DATA IN NATURAL OIL SLICK DETECTION, OTWAY BASIN, SOUTH-ERN AUSTRALIA.

For primary bibliographic entry see Field 5A. W91-11296

CONTAMINATION OF PONDS BY FENI-TROTHION DURING FOREST SPRAYING. Environmental Protection Service, Dartmouth

Environmental Protection Service, Dartmouth (Nova Scotia).

W. Ernst, G. Julien, and P. Hennigar.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 46, No. 6, p 815-821, June 1991. 3 tab, 19 ref.

Descriptors: \*Fenitrothion, \*Forest management, Descriptors: \*Frentrotinon, \*Forest management, Organophosphorus pesticides, \*Pesticide drift, \*Ponds, \*Spraying, \*Water pollution sources, Chemical analysis, Deposition, Forests, Insecti-cides, Path of pollutants, Pesticide residues, Phos-phorothioate pesticides, Toxicity.

Fenitrothion (O,O-dimethyl O-4-nitro-m-tolyl phosphorothioate) has been the chemical of choice in spray programs directed at forest defoliators in New Brunswick, Canada for over twenty years. A study was conducted to determine the contaminastudy was conducted to determine the contamina-tion of small ponds by forestry insecticides during operational spray programs in order to assess the exposure to lentic biological systems. Six ponds were selected within operational spray blocks of were selected within operational spray blocks of the 1989 spruce budworm spray program in New Brunswick. All blocks were sprayed with a water solution containing 11.0% fenitrothion, with a nominal application rate of 210 g active ingredi-ent/ha. Measured deposits of fenitrothion on filter paper after spray ranged from 24.3 to 0.7 mg/sq m, while mean deposits ranged from 17.6 mg/sq m on Pond 1 after the first spray event to 1.2 mg/sq m on Pond 1 after the second spray event. Mean surface water concentrations ranged from 1.5 mg/ L on Pond 2 after the first spray event to 0.04 mg/ L on Pond 5 after the second spray event. The maximum mean surface water concentrations ob-served are within the range of fenitrothion 96-hour served are within the range of fenitrothion 96-hour LC50's for salmonid fish. However, maximum surface water concentrations are rapidly attenuated due to dilution and degradation. Residue concentrations in outflow water are representative of well-mixed water column concentrations and were much lower than the surface concentrations of the ponds they drained. In some cases however, they exceeded the 20 micrograms/L threshold for lotic benthic invertebrate impact calculated in another study. The impact of forestry use of fenitrothion on benthic invertebrates in small ponds may be substantial and should be determined. (VerNooy-PTT W91-11298

TRANSPORT OF THE FUNGICIDE CHLOR-OTHALONIL FROM ITS OPERATIONAL USE ON A POND ECOSYSTEM. Inland Waters Directorate, Moncton (New Bruns-wick). Water Quality Branch.

H. J. O'Neill.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 46, No. 6, p 822-828,

June 1991. 3 fig, 7 ref.

Descriptors: "Chlorothalonil, "Fungicides, "Organochlorine pesticides, "Path of pollutants, "Ponds, "Spraying, "Water pollution sources, Chemical analysis, Hazard assessment, Pesticide residues, Pesticide toxicity, Sediment sampling,

Chlorothalonil (tetrachloro isophthalonitrile) is a fungicide used extensively in the Maritime Provinces of Eastern Canada to combat potato blight. A small watercourse on Prince Edward Island, known locally as the Cape Transverse River, was selected in the spring of 1989 as an appropriate location for concurrent field studies into the translocation for concurrent field studies into the transport and aquatic effects of chiorothalonii. The study site centered upon a small pond (0.2 ha) and sampling stations were established 0.75 km upstream of the pond, at the pond inlet, and 30 m downstream from the pond outlet. At each site, water, bottom sediments and sediment trap materials were collected before and after each of two agril overgravings. The hours perturbed the conas were collected before and after each of two aerial oversprayings. Ten hours post-spray the con-centration of chlorothalonil in whole water was observed to be 1.9 micrograms/L. However, for a period of up to 1.5 hours post-spray the mass of chlorothalonil on the suspended sediment fraction remained above 10 micrograms. After the second overspray, a maximum concentration of 365 micro-grams/L was observed at the outlet at 30 minutes grams/L was observed at the outlet at 30 mnutes post-spray, while a maximum of 452 micrograms/L was recorded at 25 minutes post-spray at the downstream location. Sediment trap materials and bottom sediments collected pre and post-spray at the upstream, inlet and downstream sites were all less than the analytical detection limit (0.004 mg/ kg). The maximum observed post-spray concentra-tion of 452 micrograms/L was above the estimated LC50 for bluegill sunfish, rainbow trout and channel catifish. Concentrations greater than 250 micrograms/L would have been sustained for 1.5 to 2 hours, under the operational conditions and stream flows encountered. Data from the first overspray indicate that chlorothalonil concentrations would have exceeded reported LC50 values for approxi-mately 4.5 hours. (VerNooy-PTT)

CONCENTRATION OF METALS IN VARIOUS LARVAL STAGES OF FOUR EPHEMEROP-TERA SPECIES.

Springborn Labs., Inc., Wareham, MA. K. M. Jop.

R. M. 30p.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 46, No. 6, p 901-905, June 1991. 1 tab, 15 ref.

Descriptors: \*Bioaccumulation, \*Bioindicators, \*Cadmium, \*Copper, \*Larval growth stage, \*Lead, \*Mayflies, \*Path of pollutants, \*Zinc, Animal tissues, Aquatic insects, Heavy metals, Poland, Tissue analysis, Water pollution effects.

Most of the surface waters in the southern part of Poland have received considerable amounts of wastewaters. Some of the industrial wastewaters contain a large amount of metals which ca biologically active, toxic or have a potential for bioconcentration. In this study, mayflies were sam-pled from the lowland stream Lane Bloto in the poloconcentration. In this study, mayrines were sampled from the lowland stream Lane Bloto in the Niepolomice Forest located near Krakow (South Poland). They were collected twice monthly over one year from the sediment and plants. Concentrations of cadmium (Cd), lead (Pb), copper (Cu) and carric (Zn) in whole bodies of the various size groups of the four mayfly species found were determined. The following mean annual concentrations (in micrograms/L) were recorded in water: 1 microgram Cd/L, 17 micrograms Pb/L, 30 micrograms Cd/L, 197 micrograms Pb/L, 30 micrograms Cd/L, 197 micrograms Pb/L, 30 micrograms Cd/L, 197 micrograms Ca/L, 193 mg Cd/L, 193 mg Cd/L, 193 mg Cd/L, 194 mg Cd/L, 194 mg Cd/L, 194 mg Cd/L, 195 mg Pb/L, 26 mg Cu/L, 193 mg Cd/L, 164 mg Cd/Pb/Cu/Cd/L, Results suggest that the exposure time for mayflies is not critical in bioconcentration of metals, i.e., Baetis vernus in 4 months accumulated as much as Leptophlebia vespertina in accumulated as much as Leptophlebia vespertina in 10 months. Also, colonization seems to be important in relation to the concentration of selective

### Group 5B-Sources Of Pollution

metals. The concentration of Cu was similar, while Cd, Pb, and Zn were slightly different in two burrowers, Ephemera dancia and E. vulgata. E. dancia was found primarily in a sandy bottom with low organic matter, while E. vulgata colonized sediments rich in organic matter. The concentrasediments from in organic matter. The concentra-tions of all measured metals decreased in consecu-tive larval stages of all four species, particularly prior to emergence. Because the concentrations of metals in whole body is regulated by physiological processes and varies substantially during the lifeprocesses and varies substantially during the ine-cycle, mayflies are of no value for biological moni-toring of metals unless the monitoring program includes their complete life cycle to account for differences in the relative metal concentration of instar stages. (VerNooy-PTT) W91-11302

MULTIMETHOD FOR PESTICIDES IN SOIL AT TRACE LEVEL.

ESWE-Inst. fuer Wasserforschung und Wasser-technologie G.m.b.H., Wiesbaden (Germany, F.R.).

For primary bibliographic entry see Field 5A. W91-11309

BEHAVIOR OF THE FUNGICIDE MBAMT IN

Zhejiang Agricultural Univ., Hangzhou (China). Dept. of Plant Protection. For primary bibliographic entry see Field 5A. W91-11315

DISTRIBUTION OF FECAL POLLUTION IN-DICATOR BACTERIA IN LAKE KINNERET. Kinneret Limnological Lab., Tiberias (Israel). T. Bergstein-Ben Dan, and L. Stone. Water Research WATRAG, Vol. 25, No. 3, p 263-270, March 1991. 4 fig, 7 tab, 21 ref.

Descriptors: \*Bioindicators, \*Fecal bacteria, \*Israel, \*Jordan River, \*Lake Kinneret, \*Path of pollutants, \*Wastewater pollution, \*Water pollution sources, Distribution patterns, Enteric bacteria, Influent water, Sedimentation, Statistical anal-

Lake Kinneret is the only natural fresh water lake in Israel and supplies 33% of the country's total water requirement. The lake is also heavily used for recreation and as a source of commercial fish-ing. The Jordan river enters Lake Kinneret at the north and provides 66% of the total water entering the lake. The Jordan also brings with it sewage from Upper Galilee, mainly during the winter floods, and is a major source of pollution to the lake. The distribution of fecal indicator bacteria in Lake Kinneret has been monitored closely over depth and time for a 1 year period along the river flow through the lake. It is apparent that factors including the Jordan River inflow rate, and sedimentation, were partly responsible for these distri-butions. Statistical analysis found the Jordan's inflow rate significantly correlated with bacterial densities at the lake's inlet. An examination was also made of the partitioning of fecal indicator bacteria between surface waters, bottom waters, and sediments in the lake. The data shows that bacterial numbers are always higher in the bottom waters than at the surface at all distances from the inlet. The partial disappearance of the enteric bac-teria was therefore due to sedimentation which proves to be an important factor in the vertical distribution of bacteria. The effects of light, dilution, H2S concentration and mortality were also found to contribute to some extent. Each bacteria in the surface water showed a different disappearance rate. The study has made clear the need assess the effects of these other contributing facassess the effects of these other contributing fac-tors. Each bacterial species has its own specific survival rate and unique response characteristics that determine its distribution over depth and time. (Doyle-PTT) W91-11322

DISTRIBUTION OF CHLOROBENZENES IN THE BOTTOM SEDIMENTS OF ISE BAY. National Research Inst. for Pollution and Resources. Yatabe (Japan).

S. Masunaga, Y. Yonezawa, and Y. Urushigawa. Water Research WATRAG, Vol. 25, No. 3, p 275-288, March 1991. 11 fig, 2 tab, 10 ref.

Descriptors: \*Chlorinated aromatic compounds. Pescriptors: "Cnornated aromatic compounts, \*Fate of pollutants, "Ise Bay, "Path of pollutants, \*Sediment contamination, Adsorption-desorption, Distribution patterns, Japan, Particle size, Sedi-ment sampling, Sediment-water interfaces, Suspended sediments, Suspended solids.

The concentrations of dichloro-, to hexachlorobenzene in the surficial bottom sediments in Ise Bay, Japan, were determined as a preliminary study of the behavior of these compounds in this coastal environment. The sediment samples were collected from 10 stations on the west coast and in Yokkai-chi Port in March 1987 and from 44 stations all ort in March 1987 and from 44 stations ail over the bay in October 1987. 1,2-, and 1,3-Dichlorobenzene, and 1,2,3-, and 1,2,4-trichlorobenzene levels were highest in the vicinity of Yokkaichi Port and Tsu-Matsuzaka Port. Higher levels of these compounds were also found in the middle of these compounds were also round in the induce of the bay. The concentrations of tetrachlorobenzene isomers were generally low but they were also higher in the vicinity of the two ports. 1,3,5-Trichlorobenzene was higher only in the vicinity of Yokkaichi. The levels of these compounds were not higher around Nagoya City, the largest city in the bay. The stations with higher dichloro-, and trichlorobenzenes concentrations in the middle of the bay covered the area where sediment particle size was small. This was also the area where downward water flow was estimated to exit. These findings indicated that these congeners were adsorbed by suspended particulates and transported by water flow. The distribution patterns, therefore, could be explained by the following effects: the distance from the source, the horizontal transport caused by the river inflows and the sedimentation caused by downward water flow. Pentachlorobenzene concentration was very low and its distribu-tion was not clear. Hexachlorobenzene had quite a different distribution pattern from other congeners, indicating that its sources were different. (See also W91-11325) (Author's abstract) W91-11324

BEHAVIOR OF CHLOROBENZENES IN ISE BAY, ESTIMATED FROM THEIR CONCENTRATIONS IN VARIOUS ENVIRONMENTAL MEDIA.

National Research Inst. for Pollution and Re-

S. Masunaga, Y. Urushigawa, and Y. Yonezawa. Water Research WATRAG, Vol. 25, No. 3, p 289-297, March 1991. 7 fig, 2 tab, 13 ref.

Descriptors: \*Chlorinated aromatic compounds, \*Fate of pollutants, \*Ise Bay, \*Path of pollutants, Adsorption-desorption, Distribution patterns, Industrial wastewater, Japan, Model studies, Sediment contamination, Sediment-water interfaces,

Field survey of pollutants in various environmental media is indispensible for modeling the behavior of organic compounds discharged into the coastal environment. In this study, the concentrations of chlorobenzenes were measured in Ise Bay where industrial wastewater enters. Some chlorobenzene congeners, 1,3-dichlorobenzene and 1,2,4-trichlorobenzene, were detected in seawater, suspended particulate and bottom sediment samples and their behavior was analyzed. The horizontal distribu-tions showed that these chlorobenzene concentrations in the surface water and sediments were higher in the area near the shore of the industrial area than in the offshore area. The soluble chloro-benzene concentrations in the bottom water were low at all stations. The vertical distribution survey at each sampling site showed that the soluble con-centrations were high in the surface water and low in the bottom water, but that those in the suspend-ed particulates and the bottom sediments (dry solid base) had relatively similar concentrations. This indicated that chlorobenzenes in the bottom suspended particulates and in the bottom sediments were not equilibrated with chlorobenzenes in the bottom seawater. This could be explained by the following chlorobenzene behavior: the chlorobenzenes were adsorbed by suspended particulates in

the surface water and settled to the bottom swiftly through less polluted seawater in the lower water layer with little desorption. This caused the chlor-obenzene concentration gradient in the bottom sediment which reflected the chlorobenzene concentration adsorbed by suspended particulates in the surface water. The behavior of chlorobenzenes suggested in this study showed that the use of chemical fate models based on the assumption that the soluble fraction and the fraction adsorbed by suspended particulates are always in equilibrium may yield misleading results. (See also W91-11324) (Author's abstract) W91-11325

1-NAPHTHALENESULFONIC ACID AND SUL FATE AS SULFUR SOURCES FOR THI GREEN ALGA SCENEDESMUS OBLIQUUS. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Biotechnologie. For primary bibliographic entry see Field 5D. W91-11326

METHYL AND BUTYLTIN COMPOUNDS IN WATER AND SEDIMENTS OF THE RHINE

Max-Planck-Inst. fuer Chemie, Mainz (Germany, F.R.). Biogeochemistry Dept. L. Schebek, M. O. Andreae, and H. J. Tobschall. Environmental Science and Technology ESTHAG, Vol. 25, No. 5, p 871-878, May 1991. 5 fig, 6 tab, 27 ref.

Descriptors: \*Germany, \*Organic compounds, \*Organotins, \*Pollutant identification, \*Rhine River, \*Sediment contamination, \*Tin, \*Water pollution sources, Analytical methods, Butylin, Chemical speciation, Methyltin, Wastewater facili-

A study was made of the occurrence of inorganic tin and methyl-butyltin and n-butyltin compounds in water and sediments of the Rhine river. Speciain water and sediments of the Rhine river. Specia-tion was performed by volatilization of the tin species as the corresponding hydrides, separation on a chromatographic packing material, and detec-tion by atomic absorption spectrometry. Sediments were extracted by refluxing in a methanol/HCI solution. The analysis of the Rhine water samples showed dimethyltin, monobutyltin, and dibutyltin to be present in the low ppt range. The Rhine sediments contained methyl-butyltin and butyltin compounds in the mid ppb range. High concentra-tions of tributyltin were found in samples from harbor locations. The contributions of the various sources to the overall input of methyl-butyltin and butyltin compounds into the Rhine are believed to come from the effluents from municipal sewage plants. (Author's abstract) W91-11335

PATHWAYS OF SILVER UPTAKE AND TROPHIC TRANSFER IN ESTUARINE ORGA-NISMS.

Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab. D. B. Connell, J. G. Sanders, G. F. Riedel, and G.

Environmental Science and Technology ESTHAG, Vol. 25, No. 5, p 921-924, May 1991. 2 fig, 2 tab, 28 ref.

Descriptors: \*Estuaries, \*Food chains, \*Marine organisms, \*Path of pollutants, \*Silver, Chemical speciation, Diatoms, Dissolved solids, Estuarine sediments, Geochemistry, Shrimp, Trophic level.

Recent evidence has suggested that the uptake of Ag by some aquatic organisms occurs from Ag dissolved in the water column, and not through uptake from Ag-contaminated phytoplankton or particles. In addition, it has also been shown that Ag may bind quite strongly to algal cells thus making Ag unavailable to herbivores. One series of making Ag unavailable to networks. One series of experiments were performed to investigate the mechanisms controlling Ag uptake by the grass shrimp, Palaemonetes pugio. The shrimp were exposed to elevated Ag either dissolved in the water column or associated with planktonic or detrital

### Sources Of Pollution-Group 5B

food particles. The shrimp were fed 10% of their food particles. The shrimp were fed 10% of their body weights for 4-6 hours on a daily basis. The results of the investigation revealed that P. pugio rapidly incorporated Ag dissolved in brackish water in proportion to its concentration, but did not incorporate significant quantities of Ag from the food sources containing elevated Ag contents. In another set of experiments, Ag uptake and retention was investigated in the centric diatom, Thalassiosira weissflogii. The outcome of the experiments showed that, once incorporated, Ag remained tightly bound to the cell membrane, even after cells were disrupted by sonication, leached at mained tightly bound to the cell membrane, even after cells were disrupted by sonication, leached at low pH, or treated with digestive enzymes. Thus, the acts of feeding and digestion by invertebrates are not likely to dislodge Ag from biotic particles and food-borne transfer of Ag within aquatic food chains is unlikely to occur. Geochemical controls over dissolved silver speciation and bioavailability are much more important in determining Ag incorporation. (Korn-PTT) W91-11337

BIOCONCENTRATION OF CHLORINATED AROMATIC HYDROCARBONS IN AQUATIC MACROPHYTES.

MACROPHYTES.
Windsor Univ. (Ontario). Great Lakes Inst.
F. A. P. C. Gobas, E. J. McNeil, L. Lovett-Doust,

A. P. C. Goos, and G. D. Haffner.
Science and G. D. Haffner. Environmental Science and Technology ESTHAG, Vol. 25, No. 5, p 924-929, May 1991. 5 fig, 1 tab, 16 ref.

Descriptors: \*Bioaccumulation, \*Chlorinated hydrocarbons, \*Macrophytes, \*Path of pollutants, Adsorption, Chemical interactions, Kinetics, Mathematical studies, Myriophyllum, Plant water potential, Solubility.

Because of their limited mobility, their abundance in many aquatic systems, and their potential to sorb organic substances, aquatic macrophytes have the potential to function as in situ biomonitors of waorganic substances, aquatar mastrophytes have the potential to function as in situ biomonitors of waterborne contamination. A set of experiments were conducted to investigate the bioconcentration and the uptake and elimination kinetics of a series of nonreactive, hydrophobic organic substances investigated in the submerged aquatic macrophyte, Myriophyllum spicatum. The substances selected covered a wide range of aqueous solubilities and octanol-water partition coefficients (Kow). The results of the experiments revealed that the plantwater bioconcentration factor followed a linear relationship with the octanol-water partition coefficient for all chemicals. In addition, the uptake and elimination rate constants tended to follow a 'biphasic' relationship with Kow. The experimental calculations illustrate that chemical bioconcentration may have a significant effect on the distribution and dynamics of hydrophobic organic substances in aquatic systems. (Korn-PTT)

BRINE-INDUCED ADVECTION OF DIS-SOLVED AROMATIC HYDROCARBONS TO ARCTIC BOTTOM WATERS. Science Applications International Corp., San

Diego, CA.
J. R. Payne, L. E. Hachmeister, G. D. McNabb, H.

E. Sharpe, and G. S. Smith.
Environmental Science and Technology
ESTHAG, Vol. 25, No. 5, p 940-951, May 1991. 9
fig, 4 tab, 46 ref. National Oceanic and Atmospheric Administration (NOAA) Contract No. 84-ABC-00121: RU 664

Descriptors: \*Bottom water, \*Brines, \*Hydrocarbons, \*Ocean circulation, \*Oil pollution, \*Oil spills, \*Path of pollutants, Advection, Evaporation, Field tests, Mixing, Sea ice.

Extruded brine, generated during sea ice formation in nearshore arctic waters, can sink to the bottom and form a stable bottom boundary layer. This layer can persist for periods of up to 4-6 months. Limited quantities of dissolved aromatic hydrocarbons resulting from a spill of crude oil or refined petroleum distillate products during periods of ice growth then can be transported as conservative components to the benthes with sinking brine. components to the benthos with sinking brine. Once incorporated into the stable bottom boundary layer, these aromatic components are no longer Ty layer, tries a domain components are no long-subject to loss by evaporative processes, and they only can be diluted by ultimately mixing with uncontaminated water masses, a process that pro-ceeds slowly throughout the ice-covered period. This mechanism for the transport of dissolv Inis mechanism for the transport of dissolved ny-drocarbons has been demonstrated through labora-tory test-tank simulations and a chemical/physical oceanographic field program conducted in the Chukchi Sea near Pt. Franklin, AK in March 1985. The results demonstrate a mechanism by which a spill of crude oil or refined products in a refreezing lead system could result in elevated concentrations of dissolved aromatics in bottom waters. Potential of dissolved aromatics in bottom waters. Potential problems with extrapolation of the results from this experiment to an actual oil spill would involve consideration of the type and volume of oil (or petroleum product) spilled, the degree of weathering of the oil prior to mixing with brine, the duration of the ice (brine) formation process, and the degree of water column density stratification and depth. (Author's abstract)

MAJOR INCIDENT OF DIOXIN CONTAMINA-TION: SEDIMENTS OF NEW JERSEY ESTU-ARIES.

Lamont-Doherty Geological Observatory, Pali-

sades, NY.

R. F. Bopp, M. L. Gross, H. Tong, H. J. Simpson, and S. J. Monson.
Environmental Science and Technology
ESTHAG, Vol. 25, No. 5, p 951-956, May 1991. 4
fig, 1 tab, 28 ref. New Jersey Department of Environmental Protection Contracts P 24096 and P 50582, National Science Foundation Grant CHE-8620177, and Hudson River Foundation Grant HUD/015/86B/001.

Descriptors: \*Dioxins, \*Estuaries, \*New Jersey, \*Path of pollutants, \*Sediment contamination, Industrial wastes, Phenols, Pollutant identification, Radioactive dating, Radioactive tracers, Water pollution sources.

2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) was measured in sediments and suspended matter samples from estuaries adjacent to an industrial site in Newark, N.J., where chlorinated phenois had been produced. Present day and recent historical levels of 2,3,7,8-TCDD contamination were established through the use of radionuclide time tracers (7Be, 137Cs). Concentrations up to 21,000 parts per trillion (ppt) were found in sediments deposited near the site. Pre-1950 production of DDT at the same industrial site provided another sensitive pollutant source tracer. The total deposition of 2,3,7,8-TCDD in Newark Bay sediments since the late 1940s has been approximately 4-8 kg, among the largest releases documented to 4-8 kg, among the largest releases documented to date. Sediments dredged from estuaries in this date. Sediments dredged from estuaries in this region have been disposed of on land surrounding Newark Bay and at a coastal ocean dumpsite. The current practice of subaqueous disposal of sediments dredged from these waters at a coastal ocean dump site provides for the significant and perhaps dominant transport of 2,37,8-TCDD to the continental shelf of the northeastern United States. (Author's abstract) W91-11341

PHENYLTINS IN WATER, SEDIMENT, AND BIOTA OF FRESHWATER MARINAS. Eidgenoessische Anstalt fuer Wasserversorgung,

Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).

Dendor (Switzerhald).

K. Fent, and J. Hunn.

Environmental Science and Technology

ESTHAG, Vol. 25, No. 5, p 956-963, May 1991. 7

Descriptors: \*Antifoulants, \*Biological magnifica-tion, \*Freshwater mussels, \*Compounds, \*Organotins, \*Path of pollutants, \*Sediment contamination, \*Switzerland, \*Tin, \*Water pollution sources, Cores, Freshwater, Organic compounds, Pollutant identification, Season-

A series of phenyltins and butyltins were deter-mined in the water column, sediment, and biota of

two freshwater marinas of Lake Lucerne, Switzertwo freshwater marinas of Lake Lucerne, Switzerland. Considerable concentrations of triphenyltin (TPT), diphenyltin (DPT), and monophenyltin (MPT) were found for the first time in all the compartments. In addition, tributyltin (TBT), dibutyltin (DBT), and monobutyltin (MBT) occurred in significant concentrations. During the period 1985-1990, aqueous TBT concentrations followed a seasonal pattern with increases of up to 752 ng/L in late sering followed by a successive decrease. in late spring, followed by a successive decrease until winter, when concentrations remained around 100 ng/L. TPT and TBT concentrations decreased ItO ng/L. IPI and IBI concentrations decreased during the observation period. Of the total aqueous TBT, 95-99% was present in the dissolved phase. In the mussels, Dreissena, TPT and TBT residues ranged up to 3.88 and 9.35 micrograms/g, respectively. Vertical sediment core profiles showed the highest TPT and TBT concentrations of up to 107 and 2043 micrograms/g, respectively, in the top highest TPT and TBT concentrations of up to 107 and 2043 micrograms/kg, respectively, in the top with decreasing values with depth. Dating of the core and the ocurrence of only low concentrations of DBT and MBT indicate that TBT is conserved in these sediments over a time period of years. (Author's abstract) W91-11342

ELECTROLYTIC MODEL SYSTEM FOR REDUCTIVE DEHALOGENATION IN AQUEOUS ENVIRONMENTS.

Stanford Univ., CA. Dept. of Environmental Engi-

C. S. Criddle, and P. L. McCarty.

Environmental Science and Technology ESTHAG, Vol. 25, No. 5, p 973-978, May 1991. 8 fig. 4 tab, 48 ref. U. S. National Science Founda-tion Grant ECE-8519243.

Descriptors: \*Aquatic environment, \*Biodegrada-tion, \*Chlorinated hydrocarbons, \*Dehalogena-tion, \*Electrolysis, \*Fate of pollutants, \*Water pol-lution treatment, Carbon dioxide, Carbon monoxide, Chemical reduction, Chlorides, Dichlorometh-ane, Electrochemistry, Formate, Hydrolysis, Mi-crobial degradation, Tetrachloromethane, Trichlo-romethane, Wastewater treatment.

Tetrachloromethane (CT) is transformed in biological systems via two major pathways: hydrogeno-lysis to trichloromethane (CF) and hydrolysis to carbon dioxide. The mechanism of hydrolysis is poorly understood. One possibility is a hydrolytic reduction of CT to formate or carbon monoxide followed by oxidation to carbon dioxide. In biologfollowed by oxidation to carbon dioxide. In biological systems, formate and carbon monoxide are readily oxidized to carbon dioxide, making their identification difficult, but in an electrolysis cell, reduction is physically separated from oxidation, and the production of formate and carbon monoxide at a cathode can be observed. Measurements of current, chloride, CF, dichloromethane, formate, and CO upon electrolysis of CT in aqueous solution supported the conclusion that hydrogenolysis to CF and hydrolytic reduction to CO and formate are significant and competitive reductive processto Cr and nytoryte reduction to Co and formate are significant and competitive reductive process-es. Similar findings were obtained for the reduction of 1,1,1-trichloroethane via hydrogenolysis to 1,1-dichloroethane and to an unidentified dechlorinatdefinition that is a two-level to the continuation of the pathway. It is suggested that electrolysis in aqueous environments may have value as a useful tool for the understanding and control of reductive dehalogenation and as a novel treatment technology. (Author's abstract) W91-11343

STIMULATION OF THE REDUCTIVE DECH-LORINATION OF TETRACHLOROETHENE IN ANAEROBIC AQUIFER MICROCOSMS BY THE ADDITION OF TOLUENE.

Robert S. Kerr Environmental Research Lab., Ada, OK.

G. W. Sewell, and S. A. Gibson.

Environmental Science and Technology

ESTHAG, Vol. 25, No. 5, p 982-984, May 1991. 3

Descriptors: \*Aquifer systems, \*Chlorinated hydrocarbons, \*Fate of pollutants, \*Groundwater pollution, \*Model studies, \*Organic solvents, \*Toluene, Alkylbenzenes, Anaerobic conditions ene, Alkylbenzenes, Anaerobic conditions, Ben-

### **Group 5B—Sources Of Pollution**

zenes, Chemical interactions, Chlorinated solvents, Dechlorination, Michigan, Microbial degradation, Tetrachloroethylene.

Chlorinated solvents are among the most common industrial contaminants of groundwater and are industrial containmants of groundwater and are followed closely in importance by alkylbenzenes. Tetrachloroethene (PCE) is resistant to aerobic biodegradation. However, it is occasionally reductively dechlorinated in anoxic contaminated aquifers. This is particularly true if the subsurface also contains other organic compounds that can serve as electron donors and whose utilization by subsurface bacteria will deplete the available oxygen. Recent studies suggest that certain alkylbenzenes (e.g., toluene) could potentially serve as electron donors for the reductive dechlorination of PCE. The biologically mediated interactions of release the official mediated interactions of toluene and PCE under anaerobic conditions were investigated by using incubated microcosms spiked with PCE and toluene. These microcosms were constructed with aquifer solids from an area that was exposed to both alkylbenzenes and chlorinated ethenes at a site in Michigan. The overall results of the study indicated that toluene could act as an initial source of reducing potential for the reductive dechlorination of chloroethenes under anaerobic conditions. In addition, the cultivation of this consortium from a site impacted by alkylbenzenes and chloroethenes is an indication that this process may occur in contaminated aquifers. (Korn-PTT) W91-11344

## SHEEP-DIPS AS A SOURCE OF POLLUTION OF FRESHWATERS: A STUDY IN GRAMPIAN

Grampian Regional Council, Aberdeen (Scotland).

Grampian Regional Council, Abertoeen (Scotland). Dept. of Water Services.

J. W. Littlejohn, and M. A. L. Melvin.
Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 5, No. 1, p 21-27, February 1991. 3 fig, 3 tab, 8 ref.

Descriptors: \*Insecticides, \*Organochlorine pesticides, \*Path of pollutants, \*Pesticides, \*Phenols, \*Sheep dip, \*Water pollution sources, DDE, DDT, Diazinon, Organophosphorus pesticides,

During 1984-1985 freshwater samples taken from the whole catchment of the River Ugie were anathe whole catchment of the River Ugie were analyzed for levels of organochlorine and organophosphorus pesticides and levels of phenolic compounds. The concentrations of alpha-BHC, gamma-BHC, dieldrin, o.p-DDT, p.p-DDT and p.p-DDE were initially at or below the limits of detection of the analytical techniques used and were well below the maximum admissible concentrations (MAC). However, during July and August of 1984, gamma-BHC levels were found in significant concentrations at Balmoor suggesting contents of the supplementations at Balmoor suggesting concant concentrations at Balmoor suggesting con-tamination of river water by sheep dip. Diazinon, propetamphos and fenchlorphos, also found in sheep dip were found in only a few of the catchment samples at concentrations exceeding 100 nan-ograms/L. Chlorfenvinphos was found throughout the catchment with concentrations exceeding 3000 nanograms/L in some of the samples. Phenolic compounds in rivers adjacent to sheep dipping compounds in rivers adjacent to sheep dipping areas were low enough as to warrant no immediate concern. A sheep-dip tank sited, constructed, and managed according to Ministry of Agriculture, Fisheries and Food guidelines would not pose a major source of pollution for a large receiving river. (Geiger-PTT)
W91-11356

E CONCENTRATIONS IN A DRAINING AN AGRICULTURAL SIMAZINE STREAM D

STREAM DRAINING AN AGRICULTO. CATCHMENT. Institute of Hydrology, Wallingford (England). For primary bibliographic entry see Field 4C. W91-11364

DYNAMICS OF PESTICIDES IN TROPICAL CONDITIONS, 1, KINETIC STUDIES OF VOL-ATILIZATION, HYDROLYSIS, AND PHOTOL-YSIS OF DIELDRIN AND ALPHA AND BETA ENDOSULFAN.
University of the West Indies, Kingston (Jamaica).

Dept. of Chemistry.
N. C. Singh, T. P. Dasgupta, E. V. Roberts, and
A. Mansingh.
Journal of Agricultural and Food Chemistry
JAFCAU, Vol. 39, No. 3. p 575-579, March 1991.
2 fig, 6 tab, 21 ref.

Descriptors: \*Dieldrin, \*Endosulfan, \*Jamaica, \*Path of pollutants, \*Pesticides, Chemical properties, Degradation, Hydrolysis, Kinetics, Photolysis, Tropical regions, Volatility.

The importation of pesticides into Jamaica has doubled in the past ten years. This has created a need for scientific data on the environmental fate of these pesticides in tropical agroecosystems. Kinetic studies on the degradation of three common-ply used pesticides in Jamaica, dieldrin, alpha, and beta-Endosulfan, were carried out under laboratory conditions that simulated those tropical agroe-cosystems. Studies included measurements of the rate of volatilization, hydrolysis, and photolysis. Volatility from electron capture (EC) formulations on glass surfaces at 30 C was in the order of alphaon glass surfaces at 30 C was in the order of alpha-Endosulfan > dieldrin > beta-Endosulfan. Kinetic data provided first order plots of ln F vs t with correlation coefficients ranging from 0.99 to 0.85 (F is the volatilization flux expressed in micro-grams/sq cm/day and t is the time in days) and half life values ranging from 2 to 7 days. Hydroly-tic degradation rates of both alpha and beta-Endo-sulfan at 30 C decreased with pH in the sequence ( half life = 0.04 days) > pH 7.0 (half life= 25 days) > 4.5 (half life= 90 days) for a first order model. Hydrolysis of dieldrin (half life= 95 days) was insensitive to pH over the same range. Photo-lytic degradation followed a first order model and the half lives were in the order dieldrin (2.5 h) < beta-endosulfan (3.5 h) , alpha-endosulfan 920 h) in hexane solution and dieldrin (1.7 h) < beta-endo-sulfan (3.3 h) < alpha-endosulfan (48 h) in aquecus solution. Photolysis rates in sunlight were in the solution. Photolysis rates in sunlight were in the same order, but half lives were between 20 and 40 days in bulk hexane solution, while average half life was 15 h for each compound in a thin layer hexane solution. (Doyle-PTT)
W91-11375

AQUEOUS PHOTOLYSIS OF NAPROPA-

MIDE. ICI Americas, Inc., Richmond, CA. Agricultural

L. L. Chang, B. Y. Giang, K. Lee, and C. K.

Tseng. Journal Journal of Agricultural and Food Chemistry JAFCAU, Vol. 39, No. 3. p 617-621, March 1991. 6 fig, 1 tab, 12 ref.

Descriptors: \*Degradation products, \*Fate of pol-lutants, \*Herbicides, \*Napropamide, Chemical properties, High performance liquid chromatogra-phy, Mass spectrometry, Nuclear magnetic reso-nance, Photolysis.

Napropamide is the active ingredient in Devrinol, a preemergence herbicide for controlling weeds in certain fruit and nut crops. The photolysis rate of napropamide in water was determined and the degradation products formed were identified and degradation products formed were identified and quantified in order to assess the environmental impact posed by the use of napropamide. Photolysis of napropamide was examined at 25 C in aquestion of the propagation of the propagation of the propagation of the dark, napropamide degraded rapidly upon irradiation with simulated light. The pseudo-first-order photolysis half-life and rate constant were 5.7 min and 0.127 min, respectively. Three major photodegradation products were produced in yields up to 20%, 27% and 9%. The three photodegradation products were isolated by high performance liquid chromatography (HPLC) and their structures identified by nuclear magnetic restinance (NMR) and mass spectrometry. The mass spectral data suggested that two of these are isomers of napropamide having a molecular weight (MW) of 271 and suggested that two of these are isomers of napropa-mide having a molecular weight (MW) of 271 and the third appears to be a coupling of two molecules of napropamide having a MW of 540. Examination of the structures of the photodegradation products suggests that aqueous photolysis involves an initial rearrangement of the propanamidyl group to the 2-position or to the 4-position of the naphthaleny-

loxy (ing. Coupling at the 4-position is responsible for yielding the 540 MW product from one of the 271 MW isomers, but coupling involving the 2-position was not observed, presumably due to steric hindrance. Photodegradation of napropamide is significantly faster in water than in soil. (Doyle-PTT)

MICRORIAL DECHLORINATION OF THE HERBICIDE METOLACHLOR.

Pennsylvania State Univ., University Park. Dept. of Agronomy.

of Agronomy.

S. Liu, A. J. Freyer, and J. Bollag.

Journal of Agricultural and Food Chemistry

JAFCAU, Vol. 39, No. 3. p 631-636, March 1991.

6 fig., 4 tab, 11 ref. U.S. Dept of Agriculture Grant

89-COOP-1-4731.

Descriptors: \*Biodegradation, \*Fate of pollutants, \*Herbicides, \*Metolachlor, \*Microbial degradation, \*Path of pollutants, Culturing technique, Degradation products, Dehalogenation, High performance liquid chromatography, Mass spectrometry, Streptomyces.

Dechlorination is an important reaction since it usually results in the detoxification of pesticides and herbicides. The ability of four microbial strains to dechlorinate metolachlor was studied in order to determine the mechanism of transformation and to isolate and identify the formed products. Strepto isolate and identify the formed products. Streptomyces sp., Phanerochaete chrysosporium, Rhizoctonia praticola, and Syncephalastrum were grown in a medium containing 0.35 mM metolachlor. A significant amount of the herbicide was dechlorinated by all cultures, resulting in the formation of seven dechlorinated products as determined by high performance liquid chromatography and mass spectrometric analyses. Transformation mechanisms included dehalogenation with subsequent hydroxylation of the chloroscetyl subsequent hydroxylation of the chloroacetyl group; further reactions led to ring formation between the acetyl group and the benzylic ethyl side chain. Dehalogenation in conjunction with demethylation at the N-alkyl substituent and hydroxmethylation at the N-alkyl substituent and hydrox-ylation at the aralkyl side chain were also ob-served. Streptomyces was the most active culture in dechlorinating metolachlor; 41% of the added herbicide was recovered as dechlorinated products after a 16 day incubation period. Dechlorinated products from P. chrysoporium, R. Praticola, and S. racemosum amounted to 28.4, 26.8, and 13.5% S. racemosum amounted to 28-4, 26.8, and 13.3% respectively, of the originally added metolachlor. Upon incubation of product metabolites G or I with Streptomyces, both compounds were further transformed, indicating metabolism of the primary products. Results suggest that metolachlor can be dechlorinated by microorganisms, but the accumulation. lation of dechlorinated products differed with species. (Doyle-PTT) W91-11377

GROUNDWATER CONTAMINATION BY ANTHROPOGENIC ORGANIC COMPOUNDS FROM WASTE DISPOSAL SITES: TRANSFOR-MATIONS AND BEHAVIOR.

Mount Royal Coll., Calgary (Alberta). Dept. of Chemical and Biological Sciences. R. Saint-Fort.

Journal of Environmental Science and Health (A) JESEDU, Vol. 26, No. 1, p 13-62, 1991. 4 fig, 13

Descriptors: \*Fate of pollutants, \*Groundwater pollution, \*Land disposal, \*Landfills, \*Organic pollutants, \*Path of pollutants, \*Waste disposal, Adsorption, Chemical wastes, Hazardous wastes, Planning, Solute transport.

Recent years have witnessed a dramatic rise in production and use of synthetic organic chemicals. It becomes apparent that modern society must either dispose of the enormous quantities of residual products (wastes) that it generates or in some way minimize or reprocess those residuals. However, in North America, as in most areas of the world, the safe disposal and management of chemi-cal wastes are becoming increasingly important as occurrences of groundwater contami

Sources Of Pollution-Group 5B

ported. After the disposal of chemical wastes in the ground, the potential for constituent(s) to leach from a disposal site, to reach the groundwater, to pressist or to be attenuated, depends on its inherent physico-chemical properties, and its resistance to removal by complex interactive physical, chemical and biological reactions in the surrounding soil-groundwater media. Effective strategies for action, contingency plans and health hazards associated with groundwater contamination in relation to water diseased acceptance to the property of the with groundwater contamination in relation to waste disposal associated problems require an integrated approach encompassing the physical and biochemical environmental interactions with the waste. Of greatest concern are anthropogenic organic contaminants which can not only be persistent and nonvolatile, but may also exhibit mobility across disposal site boundaries; a combination which may have undesirable environmental consequences. Moreover, unsegregated wastes containing a multitude of compounds represent special complex problems due to their different attenuation and chromatographic distribution characteration and chromatographic distribution characteristics at a disposal site. (Author's abstract)
W91-11378

MIGRATION AND TREATMENT OF A DENSE AQUEOUS CONTAMINANT SOURCE AND PLUME. Rutgers - The State Univ., Piscataway, NJ. Dept. of Chemical and Biochemical Engineering. For primary bibliographic entry see Field 5G. W91-11380

TRACE ELEMENT DISTRIBUTION IN SURFI-CIAL SEDIMENTS OF THE NORTHERN TYRRIENIAN SEA: CONTRIBUTION TO HEAVY-METAL POLLUTION ASSESSMENT. Pisa Univ. (Italy). Dipt. di Scienze dell'Ambiente e del Territorio. del Territorio.
For primary bibliographic entry see Field 5A.
W91-11444

HEAVY METAL DISTRIBUTION IN THE GODVARI RIVER BASIN,

Mineral Exploration Corp., Nagpur (India). G. Biksham, V. Subramanian, A. L. Ramanathan,

O. Diksham, V. Subramanian, A. L. Ramananian, and R. Van Grieken.
Environmental Geology and Water Sciences EGWSEI, Vol. 17, No. 2, p 117-126, March/April 1991. 8 fig, 7 tab, 18 ref.

Descriptors: \*Bed load, \*Chromium, \*Copper, \*Godavari River, \*Heavy metals, \*India, \*Nickel, \*Path of pollutants, \*Sediment contamination, \*Sediment load, \*Suspended sediments, \*Urbanization, \*Water pollution sources, \*Zinc, Iron, Manganese, Spatial distribution, Temporal distribution

Suspended and bed sediments collected from the entire region of the Godavari River basin were analyzed for Fe, Mn, Cr, Cu, Ni and Zn. There are analyzed for Fe, Mn, Cr, Cu, Ni and Zn. There are pronounced temporal and spatial variations in the heavy metal distributions. The concentrations of heavy metals in the suspended sediments are significantly higher than the bed sediments. Throughout the basin heavy metals are enriched in the finer fractions of the bed sediments. The average heavy-metal composition of the sediments is higher when compared to the average Indian river sediments. Heavy metal concentration in the two shallow cores collected shows, to some extent, the influcores collected shows, to some extent, the influ-ence of urbanization. Compared to the other tropi-cal Indian rivers such as the Krishna, the Godavari cal indian rivers such as the Arisania, the Oodavari appears to be a significant contributor of heavy metals to the Bay of Bengal. Fluxes to the Bay of Bengal are very significant considering the enormous sediment load of the Godavari River (170 million tons per year). Except for the Pranhita, other tributaries of the Godavari do not contribute other tributaries of the Godavari do not contribute significant loads of heavy metals. All metals show high correlations among themselves and the correlation is more pronounced in suspended sediments than in the bed sediments. (Author's abstract) W91-11445

LEAD SORPTION IN CALCAREOUS SOILS. Alexandria Univ. (Egypt). Dept. of Soil and Water E. A. Elkhatib, G. M. Elshebiny, and A. M. Balba.

Environmental Pollution ENPOEK, Vol. 69, No. 4, p 269-276, 1991. 3 fig, 3 tab, 15 ref.

Descriptors: \*Calcareous soils, \*Heavy metals, \*Isotherms, \*Lead, \*Path of pollutants, \*Sorption, Adsorption, Calcium carbonate, Carbonates, Clay soils, Correlation analysis, Energy, Mathematical studies, Sandy soils, Soil types, Temperature.

Samples of three surface soils (0-30 cm) differing in Samples of three surface soils (0-30 cm) differing in location, origin, texture, and calcium carbonate content (clay, CaCO3-rich, and sandy soils, respectively), were used to study the adsorption of lead by calcareous soils at three different temperatures. The quantity of Pb sorbed by the soils followed the trend CaCO3-rich > clay > sandy. The greater amount of Pb sorbed by the CaCO3-rich soil may result from the greater quantity of calcium carbonate present. The Freundlich equation successfully described Pb sorption over an initial concentration range of 0.121-3.861 mM Pb. Freundlich K sub f values at any given temperature were centration range of 0.121-3.801 mM Pt. Freunding.

K sub f values at any given temperature were smaller for the sandy soil than for the other soils. This strongly suggests that the total sorption capacity of CaCO3-rich soils is much higher than that of the clay and sandy soils, possibly due to the formation of lead carbonate. The sorption data conformed to the Langmuir isotherm and also followed the Freundlich isotherm. For comparison, for goodness of fit in the linear form of the equ for goodness of fit in the linear form of the equa-tions, the average correlations were 0.957 for the Freundlich and 0.971 for the Langmuir isotherms. It is preferable to use the Langmuir isotherm, because the adsorption maximum can then be cal-culated. The Langmuir adsorption, K sub L, relatcunact. I ne Langmur ausorption, K sub L, relation to the energy of adsorption of Pb to the soil surface, was smallest for the clay soil, suggesting that Pb was more loosely bound and more available to plants. For all soils, the binding constant increased with temperature. (Doria-PTT) W91-11453

226-RA AND OTHER RADIONUCLIDES IN WATER, VEGETATION, AND TISSUES OF BEAVERS (CASTOR CANADENSIS) FROM AVATERSHED CONTAINING U TAILINGS

NEAR ELLIOT LAKE, CANADA.
Laurentian Univ., Sudbury (Ontario). Dept. of Biology. F. V. Clulow, M. A. Mirka, N. K. Dave, and T. P.

Lim. Lim.
Environmental Pollution ENPOEK, Vol. 69, No. 4, p 277-310, 1991. 7 fig. 7 tab, 54 ref. National Sciences and Engineering Research Council of Canada Operation Grant A-5070.

Descriptors: \*Beavers, \*Bioaccumulation, \*Elliott Lake, \*Mine wastes, \*Path of pollutants, \*Radioi-sotopes, \*Radium radioisotopes, \*Tissue analysis, \*Uranium mining, Bioindicators, Canada, Correla-tion analysis, Food chains, Kidneys, Lead radioiso-topes, Liver, Muscle, Population exposure, Water analysis

Radionuclide levels were measured in tissues, gut Radionuclide levels were measured in tissues, gut contents, diet items, and water at site of capture of adult beavers from the Serpent River drainage basin, which contains uranium tailings at Elliot Lake, Ontario, and from nearby control sites. Levels of 226-Ra in beaver bone, muscle, and kidney were highest in animals from locations close to U tailings; liver levels did not vary by site. Environmental 226-Ra levels were within ranges previously reported at these or similar locations elsewhere; levels in beaver gut contents reflected levels in diet items. Concentration ratios exceeded unity only between some vegetation items and beaver bone at the Elliot Lake site and were < 0.19 between vegetation and other tissues. In two beavers with tissue levels of 226-Ra higher than others sampled, neither 232-Th nor 230-Th were detected in bone, muscle, or liver tissues. 238-U was measurable in bone, muscle, and liver; 228-Th in bone; 210-Po in bone, muscle, and liver; 228-Th in bone; 210-Po in bone, muscle, and liver; and 210-Pb only in bone. Estimated yearly intakes of radionuclides by people eating beavers were calculated to be below current allowable levels set by the Canadian regulatory authorities. The beaver is judged unsuitable as an indicator (biomonitor) of environmental radionuclide contamination, as correlation between bone and ambient (water) levels of 226-Ra is poor. (Author's abstract) contents, diet items, and water at site of capture of

W91-11454

STUDIES ON THE EFFECTS OF SOME OR-GANIC POLLUTANTS ON THE HEAVY METAL TRANSPORT IN AN INDIAN SOIL, Aligarh Muslim Univ. (India). Dept. of Applied Chemistry.

For primary bibliographic entry see Field 5C. W91-11457

RADIOACTIVITY IN WATER TREATMENT WASTES: A USEPA PERSPECTIVE.

Environmental Protection Agency, Washington, DC. Office of Drinking Water M. J. Parrotta.

Journal of the American Water Works Association JAWWA5, Vol. 83, No. 4, p 134-140, April 1991. 2 fig, 4 tab, 21 ref.

Descriptors: \*Environmental policy, \*Radioactivity, \*Water pollution sources, \*Water treatment, Administrative agencies, Aeration, Anion exchange, Cation exchange, Coagulation, Filtration, Liming, Public health, Radium radioisotopes, Radon radioisotopes, Reverse osmosis, Standards, Uranium radioisotopes.

Certain water treatment processes effectively remove naturally occurring radionuclides. Treat-ment wastes containing radiation at levels higher than background can cause disposal problems and raise public health concerns. Technologies that raise public health concerns. Technologies that appear to be effective for radionuclide removal from water include coagulation-filtration (uranium), lime softening (radium and uranium), anion exchange (uranium), cation exchange (radium), mixed-bed ion exchange (beta particles), reverse somosis (uranium, radium, and beta particles), and aeration (radon). U. S. Environmental Protection aeration (radon). U. S. Environmental Protection Agency guidance is provided in a document entitied, 'Suggested Guidelines for the Disposal of 
Drinking Water Treatment Wastes Containing 
Naturally Occurring Radionuclides.' This document should assist state agencies, water utilities, 
and others involved in the design of treatment and 
disposal operations. Where treatment exists (or is 
planned) that removes naturally occurring radionuclides from water, careful study and field and pilot 
tests for determining waste characteristics are appropriate prior to design of safe and efficient disposal operations. Treatment modifications of other posal operations. Treatment modifications of other measures should be explored to minimize water treatment wastes and to recycle, reuse, or other-wise recover wastes (or particular chemical con-stituents) to reduce the disposal problem. (Doria-PTT) W91-11461

RADON IN HOMES FOLLOWING ITS REDUCTION IN A COMMUNITY WATER

Maine Medical Center, Portland. Dept. of Re-

P. W. Rand, E. H. Lacombe, and W. D. Perkins. Journal of the American Water Works Association JAWWA5, Vol. 83, No. 4, p 154-158, April 1991. 6 fig, 1 tab, 12 ref.

Descriptors: \*Air pollution sources, \*Path of pollutants, \*Radon, \*Water supply, Aeration, Fate of pollutants, Frozen ground, Maine, Measuring instruments, Monitoring, Radiochemical analysis, Rural areas, Snow cover, Standpipes, Steep Falls, Water analysis, Well fields, Wind velocity.

Radon in home air and domestic water supplies was measured throughout a rural community (Steep Falls, Maine) before and after the installation of a diffused aeration system that reduced water radon at the source from approximately 20,000 to <1,000 pCi/L. Analysis of hydrant water showed a gradual decline in radon with increasing distance from the well field. Data indicated two major sources of radon loss within the system: (1) serial samples from a hydrant at the base of the standpipe showed a 90% decrease of radon at certain times of the day; and (2) threemonth integrated water measurements in 21 homes showed a 40% loss from near the well fields to the Radon in home air and domestic water supplies

### **Group 5B—Sources Of Pollution**

end of the system 1 mile away. This suggests that decay time should not be overlooked when water radon levels are marginally elevated. Reducing water radon did not result in a consistent decrease in air radon in the living areas of homes as measured by three-month integrated radon track detec-tors. Expected radon differences were further modified by the characteristics of each house (e.g., air volume and the use and placement of wood stoves) and the household use of water. Further blicating radon measurement is the natural bility from year to year in wind velocity, depth of frozen ground, snow cover, and barometric pressure, as well as changes in home use. Finally, the range of error of the track-etch detectors 13, the range of error of the track-etch detectors makes demonstration of small air radon differences very difficult. Future studies should include continuous monitoring in addition to long-term track-etch detection. (Doria-PTT)

FOREST INDUSTRY WASTEWATERS. For primary bibliographic entry see Field 5D. W91-11467

## IDENTIFICATION OF DIOXIN SOURCES IN AN INTEGRATED WOOD PROCESSING FA-

New Zealand Forest Products Ltd., Tokoroa. D. N. Campin, S. J. Buckland, D. J. Hannah, and J. A. Taucher.

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 65-74, 1991. 10 fig, 1 tab, 11 ref.

Descriptors: \*Chlorinated hydrocarbons, \*Dioxins, \*Industrial wastes, \*Pulp and paper industry, \*Pulp wastes, \*Water pollution sources, Furans, Kraft mills, Pollutant identification, Toxic wastes, Toxicity.

A study was undertaken of the PCDD (polychlori-nated dibenzo-p-dioxin) and the related PCDF (di-benzofurans) export vectors from a major facility that comprises a bleached kraft pulp mill, paper mills, and previously, a timber processing sawmill. The PCDD and PCDF levels in pulps, untreated effluent, the final effluent, sludges, and discharge to the receiving waters were examined. The total toxic equivalents were calculated, and the individual PCDD and PCDF profiles showed that there were several contributing sources of dioxins. Despite the combination of very large flows with very low concentrations highly conservative mass balances of PCDD and PCDF translocation through a major effluent treatment system have been demonstrated. Congener profiles of PCDDs and PCDFs in benthic deposits demonstrate a high degree of similarity to the overlying water column. Discharge of PCDDs and PCDFs from the bleachperations account for 25% of the North At-Treaty Organization toxic equivalents enterlantic Treaty Organization toxic equivalents enter-ing the recipient at the time of sampling. Pentach-lorophenol may be a significant source of PCDDs and PCDFs and could account for 60% of the NATO toxic equivalents input to the recipient from the site. Measurement of congener profiles offers an effective method of identifying PCDD and PCDF sources. (See also W91-11467) (Mertz-PTT) W91-11475

### ORGANOHALOGENS OF NATURAL AND IN-DUSTRIAL ORIGIN IN LARGE RECIPIENTS OF BLEACH-PLANT EFFLUENTS.

Linkoeping Univ. (Sweden). Dept. of Water and Environmental Research. A. Grimvall, H. Boren, S. Jonsson, S. Karlsson,

and R. Savenhed.

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 373-383, 1991. 9 fig, 2 tab, 28 ref.

Descriptors: \*Baltic Sea, \*Bleaching wastes, \*Chlorinated aromatic compounds, \*Chlorinated hydrocarbons, \*Path of pollutants, \*Pollutant transport, \*Vattern (lake), Lakes, Precipitation, Sweden, Water pollution, Water pollution sources.

The long-term fate of chlorophenols and adsorbable organic halogens was studied in two large recipients of bleach-plant effluents: Lake Vattern

in Sweden and the Baltic Sea. The study showed that there is a long-distance transport (>100 km) of chloroguaiacols from bleach-plants to remote parts of receiving waters. However, there was no evidence of several-year-long accumulation of chloro-organics in the water-phase. A simple water-exchange model for Lake Vattern showed that the cumulated bleach-plant discharges from the past 35 years would have increased the adsorbable organic halogens concentration in the lake by more than 100 microgram Cl/L, if no adsorbable organic halogens had been removed from the water by evaporation, sedimentation or degrada-tion. However, the observed adsorbable organic halogen concentration in Lake Vattern averaged only about 15 microgram Cl/L, which was less than the average adsorbable halogen concentration (32 microgram Cl/L) in the unpolluted tributaries of the lake. Similar investigations in the Baltic Sea showed that non-point sources, including natural halogenation processes, accounted for a substantial fraction of the adsorbable organic halogen in the open sea. The presence of 2,4,6-trichlorophenol in precipitation and unpolluted surface waters showed that non-point sources may also make a considerable contribution to the background levels of compounds normally regarded as indicators of bleach-plant effluents. (See also W91-11467) (Au-thor's abstract) W91-11505

DISTRIBUTION OF HALOGENATED ORGAN-C COMPOUNDS (AOX)—SWEDISH TRANS-PORT TO SURROUNDING SEA AREAS AND MASS BALANCE STUDIES IN FIVE DRAIN-

Swedish Environmental Research Inst., Stock-

M. Enell, and L. Wennberg. Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 385-395, 1991. 7 fig, 7 ref.

Descriptors: \*Chlorinated hydrocarbons, \*Path of pollutants, \*Pollutant transport, \*Sweden, Air pollution, Bays, Chemistry of precipitation, Drainage basins, Environmental effects, Marine pollution, Mass balance, Pollution load, Rivers, Water pollution coursed. tion sources.

Halogenated organic compounds play a dominant role in environmental pollution problems because of their persistence and bioaccumulation in organisms. A research project on long distance distri-bution of halogenated organic compounds was started in 1987 at the Swedish Environmental Research Institute. The project focused on the tran search Institute. The project focused on the transport of halogenated organic compounds, measured as adsorbable organic halogens, in Swedish rivers to surrounding sea areas. This work started in October 1987 and was finished in September 1988. Water samples were collected at 47 sampling stations in 33 drainage systems. During the same period the adsorbable organic halogen concentration in atmospheric deposition was measured at 17 sampling stations. Results showed that the annual total transport of adsorbable organic halogens to sea areas surrounding Sweden. was about 5200. sea areas surrounding Sweden, was about 5200 ton/year. Highest adsorbable organic halogen conton/year. riignest adsoroatio organic natogen con-centrations in river waters were found on the Swedish west coast (maximum 29 microgram/L) and the lowest in rivers flowing into the Bothnian Bay (maximum 29 microgram/L), in the northeast-ern part of Sweden. Analyses of adsorbable organic halogens in atmospheric deposition at sampling stations from the north to the south of Sweden, indicated that the amount of halogenated organic compounds, supplied with precipitation, was about 5100 ton/year. The mean concentration of adsorb-5100 ton/year. The mean concentration of adsorbable organic halogens in precipitation was 15 mi crogram/L. The results indicated that there were crogram/L. The results indicated that there were also sources other than anthropogenic-probably natural production of halogenated organic com-pounds. (See also W91-11467) (Mertz-PTT) W91-11506

FORMATION OF CHLOROPHENOLS AND RELATED COMPOUNDS IN NATURAL AND TECHNICAL CHLORINATION PROCESSES.

Linkoeping Univ. (Sweden). Dept. of Water and Environmental Research. F. Hodin, H. Boren, A. Grimvall, and S. Karlsson.

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 403-410, 1991. 3 fig, 16 ref.

Descriptors: \*Bleaching wastes, \*Chlorinated hydrocarbons, \*Chlorination, \*Disinfection, \*Phenols, \*Pulp wastes, \*Water pollution sources, \*Water treatment, Bromides, Chemical reactions, Chlorinated aromatic compounds, Chlorine, Hydrogen ion concentration, Hydrogen peroxide.

The formation of chloroorganics during chlorine bleaching of pulp and chlorine disinfection of drinking water has been studied by a great number of investigators. In both cases, active chlorine of investigators. In both cases, active chlorine reacts with natural organic matter, resulting in a complex mixture of low and high molecular weight chloroorganics. Surface water was halogenated by the addition of: (1) chloroperoxidase, hydrogen peroxide and chloride; (2) hydrogen peroxide and chloride; (2) hydrogen peroxide and chloride or bromide; and (3) hypochlorite. Analysis of adsorbable organic halogen, halogenated hangels and nurseable organic compounds. genated phenols and purgeable organic compounds showed that the first two reactions produced almost the same halogenated compounds. It was also shown that active chlorine occurred as an intermediate in the reaction with chloroperoxidase, hydrogen peroxide and chloride. The hydrogen peroxide and chloride or bromide reaction implied peroxide and chloride or bromide reaction implied a marked halogenation only after the addition of bromide, and this reaction was enhanced by a low pH. Existing evidence that 2,4,6-trichlorophenol may be naturally produced was strengthened. Some evidence was also obtained indicating that enzyme-mediated reactions may contribute to the natural formation of dibenzo-p-dioxins. (See also W91.11467) (Mertz-PT) W91-11467) (Mertz-PTT) W91-11508

## NITROGEN DYNAMICS OF PULP AND PAPER SLUDGE AMENDMENT TO FOREST

Washington Univ., Seattle. Coll. of Forest Re-

For primary bibliographic entry see Field 5E. W91-11510

### QUALITY OF SALMONID HATCHERY EF-FLUENTS DURING A SUMMER LOW-FLOW SEASON.

Washington State Dept. of Ecology, Olympi For primary bibliographic entry see Field 5D. W91-11532

## SOURCES AND EXTENT OF GROUNDWATER CONTAMINATION.

D. W. Moody.

Groundwater and Public Policy Series No. 3, May 1990. Soil and Water Conservation Society, Ankeny, Iowa. 8p, 2 fig, 5 ref.

Descriptors: \*Groundwater pollution, \*Water pollution sources, \*Groundwater quality, \*Path of pollutants, Waste disposal, Nitrates, Organic compounds, Iron, Manganese, Dissolved solids, Saline water intrusion, Agriculture, Land use.

Groundwater is an important source of drinking water for more than half of the nation's population and nearly all of its rural population. In recent years, widespread reports of bacteria, nitrate, synthetic organic chemicals and other pollutants in groundwater have increased public concern about the quality of groundwater. Groundwater contamiation can occur in many ways and from many sources, both natural and human induced. Groundwater. sources, both natural and numan induced. Oround-water commonly contains one or more naturally occurring chemicals, leached from soil or rocks by percolating water, in concentrations that exceed federal or state drinking water standards or other-wise impair its use. These include: dissolved solids and chloride; iron and manganese; and nitratenitrogen. Contaminants can enter groundwater from more than 30 different generic sources related to human activities. The most common sources of human-induced groundwater contamination can be grouped into four categories: waste disposal prac-tices (septic systems, landfills, surface impound-ments, injection wells, and land application of wastes); storage and handling of materials and

### Sources Of Pollution—Group 5B

wastes (leaking underground storage tanks, trans wastes (teaking underground storage tanks, trans-porting and stockpilling, mining practices, and oil-well brines); agricultural activities (fertilizers, pes-ticides, feedlots, and irrigation); and saline water intrusion. The organic substances most frequently reported in groundwater as resulting from waste disposal, in decreasing order of occurrence, are: trichloroethylene, benzene, tetrachloroethylene, phenolic compounds toluene, chloroform pen-plenolic compounds toluene. trichioroethylene, benzene, tetrachioroethylene, phenolic compounds, toluene, chloroform, pentachlorophenol, creosote, 1,1,1-trichloroethane, and xylene. Although little systematic information exists on the extent and severity of groundwater contamination, available evidence suggests that: (1) the shallowest aquifers generally are at greatest risk of contamination; (2) contamination of shallow aquifers by nitrates and synthetic organic chemi-cals is widespread in many areas; (3) shallow groundwater contamination can be related to land use; and (4) as yet, deeper aquifers, which commonly are used for public drinking water supplies, are relatively free from contamination. (Lantz-W91-11546

DETERMINATION OF SELENIUM SPECIES IN SPENT OIL SHALE LEACHATES BY ION CHROMATOGRAPHY.

University of Wyoming Research Corp., Laramie. Western Research Inst.

N. D. Niss, and C. R. Powers.

Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-000965. Price codes: A03 in paper copy, A01 in microfiche. Report No. DOE/MC/11076-2685, September 1988. 21p, 4 fig, 2 tab, 26 ref. DOE Cooperative Agreement DE-FC21-86MC11076.

Descriptors: \*Leachates, \*Selenium, \*Oil shale, Pestriptors: "Path of pollutants, Chemical speciation, Quantita-tive analysis, Sulfur, Hydrogen ion concentration, data interpretation, Nitrates, Selenite, Selenate, Sulfates, Phosphates.

The leaching and transport of trace elements from spent oil shales is a growing area for environmental concern. Selenium is often present in spent oil shales. Under the alkaline conditions present in spent western oil shale leachates, selenium species display anionic behavior, increasing their solubility and mobility. The processes that govern the partitioning of Se species between solid and solution phases are not well understood, and computer modeling is an important tool in this area. The accuracy of geochemical model predictions depends on the thermodynamic data and mathematical formulations used in their development. To assure reliability of model predictions, it is essential assure reliability of model predictions, it is essential to validate ion speciation data obtained from geochemical models with data obtained from laboratochemical models with data obtained from laborato-ry analyses. The purpose of this study was to begin developing a method for the speciation of the two most common selenium species in spent oil shale leachate, selenite (SeO3(2-)) and selenate (SeO4(2-)), using suppressed ion chromatography. The development of a quantitative method to analyze for these anions is a prerequisite to model validation work in predicting the chemical form and mobility. work in predicting the chemical form and mobility of a Se species in spent oil shale leachates. Because of the high levels of sulfur, as well as other anions typically present in spent oil shale leachates, the typically present in spent oil shale leachates, the development of a separation scheme for SeO3(2-) and SeO4(2-) must also minimize these expected interferences. Development of a Se speciation method first used a high capacity anion exchange column with the standard anion eluent (1 mM CO3/0.9 mM HCO3). This approach to the separation of SeO3(2-) and SeO3(2-) was not acceptable due to interferences from nitrate, sulfate, and phosphate. The next approach used the same column with a 1-mM carbonate eluent, adjusted to pH 12 with 10 M sodium hydroxide. The elevated pH of the eluent eliminated interference problems with the sulfate and phosphate ions, but problems developed in producing repeatable retention time and peak area data for SeO3(2-) and SeO4(2-). Repeatability problems were attributed to several factors peak area data for SeU3(2) and SeU3(2) and Seu3(2) bility problems were attributed to several factors including eluent strength, pH, eluent flow rate, and adsorption sites on the stationary phase. (Lantz-W91-11553

STATUS REPORT ON REMEDIAL INVESTI-GATION OF THE 300 AREA PROCESS PONDS, Battelle Pacific Northwest Labs., Richland, WA. For primary bibliographic entry see Field 5G. W91-11583

FATE AND TRANSPORT OF SEDIMENT-AS-SOCIATED CONTAMINANTS.

Water Science, Boulder, CO. A. J. Medine, and S. C. McCutcheon.

A. J. McCuirle, and S. C. McCuicheon. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-137068. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-89/269, 1989. 66p, 16 fig, 7 tab, 137 ref.

Descriptors: \*Biodegradation, \*Fate of pollutants, \*Path of pollutants, \*Sorption, \*Surface water, \*Suspended sediments, Adsorption, Biotransformation, Chemical reactions, Lakes, Literature review, Metals, Model studies, Organic compounds, Streams, Water quality.

Although sediments generally are considered to provide beneficial effects in terms of water quality movement through the 'sorption' of pollutants from the water column, contaminated sediments also may result in adverse effects. The interactions of both metals and organic contaminants with suspended and bed sediments significantly affect the transport and transformation of these pollutants in streams and lakes. Information about these interactions is important in sessengia heavarie of collutants. streams and takes. Information about these interac-tions is important in assessing hazards of pollutants exposure in freshwater systems. Research into the fate and transport of sediment-associated contaminants is reviewed. An overview of contaminant modeling is provided along with model descrip-tions of chemical and biological transformation processes, and research on the physical movement of contaminated sediment, including near bed sedi-ment transport and advective-dispersive transport ment transport and advective-dispersive transport in the water column. Adsorption-desorption is the most dominant of the many processes that are important in assessing the hazards associated with contaminated sediments. Additional research is needed to formulate mechanistic models that accurately reflect the adsorption-desorption process for rately reflect the adsorption-desorption process for both metals and organics in natural systems con-taining a mixture of sediment types. (Author's ab-W91-11587

PRELIMINARY DATA SUMMARY FOR THE MACHINERY MANUFACTURING AND RE-BUILDING INDUSTRY.

BUILDING INDUSTRY.
Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-126525. Price codes: A17 in paper copy, A01 in microfiche. Report No. EPA 440/1-89/106, October 1989, 381p, 5 fig, 71 tab. EPA Contract Nos. 68-03-3411, 68-03-3548, and 63-03-3339.

Descriptors: \*Data collections, \*Economic aspects, \*Industrial wastewater, \*Water pollution control, \*Water pollution sources, Costs, Environmental protection, Organic compounds.

The US EPA has conducted a preliminary study of machinery manufacturing, rebuilding, and maintenance facilities because of concern for the potential discharge of toxic and hazardous pollutants and in response to findings and recommendations made in discharge of toxic and hazardous pollutants and in response to findings and recommendations made in the Domestic Sewage Study. The purpose of the machinery manufacturing and rebuilding (MM and R) project was to prepare a preliminary data summary to assist the Agency in deciding whether to develop national effluent limitations guidelines and standards for MM and R facilities. This preliminary data summary includes two studies: a technical support study and an exponentic impact and cal support study and an economic impact and cost-effectiveness study. The results of the prelimi-nary analyses indicate that discharges of pollutants MM and R facilities are environmentally significant and that developing a regulation to con-trol these discharges is appropriate. MM and R facilities generate raw wastewater containing 150 million lbs/yr of toxic metals, 36.3 million lbs/yr of toxic organics, and 7,500 million lbs/yr of conven-tional pollutants. The total wastewater flow esti-

mated for MM and R facilities is 2.4 trillion L The MM and R raw wastewater flow and pollut-ant loading estimates are based on data represent-ing about 278,000 facilities with more than nine ing about 275,000 facilities with more than lime employees. The cost-effectiveness analysis estimated the annualized cost/pound of pollutant removed and per pound-equivalent of pollutant removed for the one control option considered by the technical analysis. Based on the cost per pound-equivalent removed, the control option considered is most cost-effective for the Office Machine Manufacturing (\$19 and \$46 per pound-equivalent removed for direct and indirect dischargers) and Aircraft redirect and indirect dischargers) and Aircraft re-building (\$28 and \$126 per pound-equivalent re-moved for directs and indirects) segments. It is least cost-effective for Bus and Truck Rebuilding (\$39,486 and \$43,444 per pound-equivalent re-moved for direct and indirect dischargers) and Bus and Truck Maintenance (\$3,627 and \$8,077 for directs and indirects). Cost per pound-equivalent removed for the remaining segments range from \$125 to \$1,791 for direct dischargers and from \$158 to \$8,061 for indirect dischargers. (Lantz-PTT) W91-11589 W91-11589

TRENDS IN WATER-QUALITY DATA IN

Geological Survey, Austin, TX. Water Resources T. L. Schertz.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4178, 1990. 177p, 25 fig, 8 tab, 18 ref, 2 plates.

Descriptors: "Hydrologic data collections, "Moni-toring, "Texas, "Water quality, "Water quality trends, Alkalinity, Brazos River Basin, Colorado River Basin, Dissolved oxygen, Guadalupe River Basin, Hydrogen ion concentration, Nutrients, Pes-ticides, Red River Basin, Rio Grande Basin, San Antonio River Basin, Sulfates, Trinity River Basin, Water pollution sources.

Data for approximately 40 water quality constituents from 117 stations in Texas were statistically analyzed for detectable trends for the 1975-86 water years. Data for approximately 35 water quality constituents from 98 stations were analyzed for detectable trends for the 1969-86 water years. The methods used were modified from those previously developed for a national trend study. The detectable trends of most inorganic constituents showed predominantly decreasing concentrations for both the 1975-86 and 1969-86 water years, although several regional trend patterns are evident. Areas of decreasing concentrations in the lower and coastal plains of Texas and increasing concentrations in the upper reaches of the Red, Brazos, and tions in the upper reaches of the Red, prazos, and Colorado River basins are evident in both time-frames for almost all of the dissolved ions, total hardness, and specific conductance. An area of increasing concentrations in the Rio Grande basin is evident for the same constituents for 1975-86, but a lack of data prior to 1974 prevented trend analysis for 1969-86. Increases in sulfate concentrations in the active coartel segment of the State partitled. sis for 1969-86. Increases in sulfate concentrations in the eastern coastal region of the State persisted for both time-frames, unlike trends in the region for the other dissolved ions. Paper mills, coal-fired, and lignite-fired power plants, and petrochemical plants common to this area may be the source of increased sulfate in the rivers. The trend patterns in nutrients and dissolved oxygen indicate improvement in the water quality in the upper Trinity River basin, possibly resulting from improvement in municipal wastewater treatment in the Dallas-Fort Worth area. Trend patterns in these constituents also indicate degradation in the water Dallas-Fort constituents also indicate degradation in the water quality of the San Antonio and Guadalupe Rivers quality of the San Antonio and Guadalupe Rivers that may be due to municipal waste from the city of San Antonio. The trends in both areas are evident in the 1975-86 and 1969-86 timeframes. Trends in pH were almost all increasing for both periods whereas trends in alkalinity were predominantly decreasing for both periods for the entire State. The cause of the widespread and opposite trends detected in these constituents is uncertain. Concentrations of trace elements and pesticide constituents were generally small and often less than the analytical detection limit. Few trends were detected for any of the constituents and none

### Group 5B-Sources Of Pollution

of the constituents demonstrated any trend patterns. (Author's abstract) W91-11593

NUTRIENT LOADING STATUS OF THE CON-ESTOGA RIVER BASIN, 1985-1989. Susquehanna River Basin Commission, Harrisburg, PA. Resource Quality Management and Protection

For primary bibliographic entry see Field 5G. W91-11599

ASSESSMENT OF AGRICULTURAL NUTRI-ENT POINT SOURCE DISCHARGE FROM TILE DRAINS, SPRING AND OVERLAND RUNOFF FROM TWO FARMS, DAUPHIN COUNTY, PENNSYLVANIA. Susquehanna River Basin Commission, Harrisburg, PA. Resource Quality Management and Protection Div.

S. Takita, A. N. Ott, J. D. Graham, and J. J.

Hauenstein. Susquehanna River Basin Commission, Harrisburg, Pennsylvania. Publication No. 135, March 1991. 95p, 16 fig, 20 tab, 3 ref, append. EPA Grant No. 1-003992-90-0.

Descriptors: \*Agricultural runoff, \*Nutrients, \*Pennsylvania, \*Tile drains, \*Water pollution sources, Agriculture, Case studies, Conestoga River Basin, Fertilizers, Land use, Nitrogen, Phos-phorus, Pollutant load, Precipitation, Surface runoff, Susquehanna River Basin.

The Halifax farm field drain and spring are located below the water table for most of the year and are, therefore, believed to be collection points for the very shallow groundwater. This situation provides very shallow groundwater. This situation provides a relatively enclosed shallow flow system which allows the calculation of a reasonable nutrient budget. The measured runoff ranged from 16% to 51% of the annual precipitation. The annual N and P loss to the combined water outflow of a tile drain, spring, and overland runoff from the 10.19 acre Halifax farmed drainage area ranged from 23 to 119 lbs/acre of N and 0.21 to 0.56 lb/acre P. The Enterline farm field drain is located at a depth which is above the water table most of the time and, therefore, only flows during and immediately following precipitation events. Unlike the Halifax flow system, this flow system ranged only from 5% to 11% of the annual precipitation, and does not warrant a nutrient budget. The nutrient loss to the water outflow of the measured Enterline flow system ranged from 4 to 10 lbs/acre N and 0.06 to the water outflow of the measured Enterline flow system ranged from 4 to 10 lbs/acre N and 0.06 to 0.11 lbs/acre P. Since slightly more than half of the drainage area is farmed and most of the remain der wooded, the yield per acre farmed is 8 to 20 lbs/acre N and 0.11 to 0.22 lbs/acre P. The 4 to 10 lbs/acre N and 0.11 to 0.22 lbs/acre P. The 4 to 10 lbs/acre N loss at Enterline is similar to the average annual N losses estimated for farmed Susquehanna River sub-basins that are at least 50% forested. The intensely farmed Conestoga River basin averages 33 lbs/acre N loss and a 2.44 lbs/acre P loss. The Halifax farm, which does not have non-ferm diluterage of farm dilution runoff, appears in the high N range, but neither farm remotely approaches the P loss found in the Conestoga or other highly farmed basins. (Author's abstract) W91-11600

### 5C. Effects Of Pollution

FEATURES OF THE LIMNOLOGICAL BE-HAVIOR OF SALTO GRANDE'S RESERVOIR (ARGENTINA-URUGUAY).

DECISION S.R.L., Buenos Aires (Argentina). L. E. Beron.

Ecological Modelling ECMODT, Vol. 52, No. 1/2, p 87-102, November 1990. 7 fig, 2 tab, 13 ref.

Descriptors: \*Argentina, \*Eutrophication, \*Lim-nology, \*Reservoirs, \*Water pollution effects, Algal growth, Cyanophyta, Ecology, Lake ecolo-gy, Microcystis, Nutrients, Physical parameters, Phytoplankton, Residence time, Secchi depth, Tur-bidity, Turbulence.

Salto Grande's reservoir (Argentina) is a river-like reservoir of 780 sq km with multiple arms. The

limnological behavior of the impoundment shows that excessive fertilization (eutrophication) in the lower half of the reservoir is of sufficient magnitude to cause impairment of recreational areas. The reservoir presents different subenvironments: several differentiated arms plus a main channel. Under normal or elevated-flow conditions, water travel time is such that less than the maximum possible time is such that less than the maximum possible number of algae develop near the dam, compared to the norm in other lakes and reservoirs. These conditions increase the time for algae development in the reservoir, and more importantly, allow for the sedimentation of inorganic turbidity, which under most conditions limits available light reducing algal group helpow, what normally occurs in a steal crowth below, what normally occurs in under most condutors limits available inja reduc-ing algal growth below what normally occurs in water bodies. At the same time some physical factors operate with unequal intensity in both sys-tems. In the lateral arms lentic conditions prevail, whereas in the main channel the intensity of the turbulence and the horizontal transport establish lotic conditions. The nutrient conditions of the lotic conditions. The nutrient conditions of the water characterize the reservoir as mesotrophic, and occasionally eutrophic. Dissolved oxygen constitution is acceptable in the lake. The relationship between Secchi depth and the hydraulic residence time clearly shows that, when the water is slow, turbidity decreases, thus more algal growth takes place. The reservoir may be considered as a system composed of two markedly different sub-systems regarding their biological manifestations: systems regarding their biological manifestations: the system of lateral arms where the phytoplank-ton is exclusively dominated by Cyanophyta, particularly Microcystis species, and the main channel characterized by diatomous algae, with absolute dominance of Melosira species. The evolution of algae concentrations, and of some physico-chemical parameters, emphasize the unequal behavior of both subsystems, implying the development and persistence of different environmental conditions. Results indicate that the phytoplankton of the reservoir is limited by the inorganic turbidity, except at the indicate that the phytoplankton of the reservoir is limited by the inorganic turbidity, except at the end of the arms, and is mainly determined by water renewal in the center of the reservoir and by the washing effect due to rainfall on the lateral arms. (Mertz-PTT) W91-10491

NEW DEAD SEA. G. L. Gist.

Journal of Environmental Health JEVHAH, p 20-22, Spring 1991. 1 fig, 1 tab.

Descriptors: \*Environmental effects, \*Oil pollution, \*Oil spills, \*Path of pollutants, \*Persian Gulf, \*Water pollution effects, Aquatic plants, Benthos, Cleanup operations, Corals, Crabs, Mangrove swamps, Mollusks, Oysters, Water pollution.

On Jan. 25, 1991, a new type of terrorism was introduced to the world. Iraqi troops released oil into the Persian Gulf from the Sea Island superand the Persian Guil from the Sea Island super-tanker loading facility and from five scuttled tank-ers located 10 miles off the coast of Kuwait. The Persian Gulf is a shallow marginal sea of the Indian Ocean. The Gulf varies in width from 35 miles at the Strait of Hormuz to 210 miles near the center. The sea floor is shallow, rarely exceeding 300 feet in depth. The effects of crude oil in open sea are seen for approximately three years after release. Since the Sea Island release was inland, the effects will be felt for a much longer time. Bottom dwellers, such as crabs, oysters and mollusks will be killed, as will the sea grass beds and algal flats, which provide food for countless other marine organisms. Several rare or endangered species of flora and fauna are threatened. Mangrove stands will be significantly affected and coral reefs will die back to at least 10 feet below the Gulf's sur-face. Populations of bottlenose dolphins, whales, hawksbill and green turtles, and caspian terns will be reduced to an unknown degree by exposure to be reduced to an unknown degree by exposure to the oil. Perhaps the most threatened species is the dugong. Cleanup will be complicated by the fact that the slick is located in a war zone. Early response has been impossible. The slick was ignited during the early part of the disaster. Burning is an effective technique against freshly spilled oil. The ocean, however, serves as a heat sink making it difficult to maintain a sustained burn. The cost of cleanup has been estimated at \$5 billion. (Mertz-PTT)

W91-10504

EFFECTS OF POLLUTION ON HETEROZY-GOSITY IN THE BARNACLE BALANUS AM-PHITRITE (CIRRIPEDIA: THORACICA), Padua Univ. (Italy). Dept. of Biology.

T. Patarnello, R. Guinez, and B. Battaglia.

Marine Ecology Progress Series MESEDT, Vol.

70, No. 3, p 237-243, March 12, 1991. 2 fig, 6 tab,

35 ref.

Descriptors: \*Barnacles, \*Crustaceans, \*Genetics, \*Italy, \*Thermal pollution, \*Water pollution effects, Chemical wastes, Electric powerplants, Heavy metals, Lagoons, Water pollution.

The effects of thermal and chemical pollution on gene and genotype frequencies and on multilocus structure were studied in 3 populations of the barnacle Balanus amphitrite Darwin from the lagoon of Venice, Italy. One of these populations (oppulation A) was subjected to high chemical pollution; the second (population B) was constantly exposed to temperatures about 10 C higher than the rest of the lagoon since it was settled in front of an electric power plant outflow; and the third (population C) was sampled in an unpolluted area of the lagoon as a control. Juvenile and adult age classes of each of the 3 samples were studied by electrophoretic analysis of the polymorphic loci Mpi, Pgi, and Pgm. Significant differences were found between Population A adults and both B and C adults for the majority of the genetic comparisons. B and C adult populations did not differ significantly. Statistical comparisons among the three juvenile populations showed a high genetic homogeneity. Comparisons between the two age classes within each of the three populations exhibited significant differences only between adults and juveniles of Population A at the level of gene and genotype frequencies. Moreover, in Population As a significant differences only between adults and juveniles of Population A aut the level of gene and genotype frequencies. Moreover, in Population As a significant differences only between adults and juveniles of B and C The effects of thermal and chemical pollution on zygote class was observed. No differences were detected between adults and juveniles of B and C samples. These results suggest the action, in Population A, of some selective factor during the postsettlement period. Thermal pollution does not seem to play any important selective role. The hypothesis is advanced that selection is determined by heavy metals. (Author's abstract) W91-10518

MEIOFAUNA OF AN EXPERIMENTAL SOFT BOTTOM ECOSYSTEM--EFFECTS OF MA-CROFAUNA AND CADMIUM EXPOSURE.

Stockholm Univ. (Sweden). Dept. of Zoology. B. Sundelin, and R. Elmgren.

Marine Ecology Progress Series MESEDT, Vol. 70, No. 3, p 245-255, March 12, 1991. 3 fig, 2 tab,

Descriptors: \*Benthic fauna, \*Bioassay, \*Cadmi-um, \*Macroinvertebrates, \*Sediment contamina-tion, \*Toxicity, \*Water pollution effects, Amphi-pods, Biomass, Ecological effects, Heavy metals, Nematodes, Seed-shrimp, Toxicology, Water pol-lution.

The effects of macrofauna (the amphipod Pontoporeia affinis) and of exposure to cadmium at 0 (control) and about 5, 50 and 150 microgram/L on a meiofauna population were studied in small, flow-through laboratory microcosms. Meiofauna was derived from a soft sediment benthos commuwas derived from a soft sediment benthos commu-nity, typical below the thermocline in the northern Baltic proper (salinity 6 to 8 parts per thousand). In a first experiment (265 days) subadult amphi-pods were added, while in a second experiment (450 days) both juveniles and subadults were in-cluded. After 265 days at natural field amphipod densities total meiofauna abundance was lower than in control experiments without amphipods. In contrast, non-nematode meiofauna, in particular Turbellaria and harpacticoids, increased in the presence of amphipods. Effects of cadmium expo-sure on the meiofauna could thus be due either to direct toxicity, or to changes in macrofaunal abundance or activity caused by cadmium. Sediment cadmium concentration was a highly significant function of cadmium concentration in the input

Effects Of Pollution-Group 5C

water. Significant negative dose-response relationships were obtained in the second experiment (460 days, with amphipods) for total meiofauna abundance and biomass, non-nematode biomass, nematode abundance, ostracod abundance and turbellarian abundance. Overall, ostracods were found particularly sensitive to cadmium exposure, while Turbellaria and monothalamous Foraminifera sometimes increased in cadmium-dosed microcosms, presumably due to reduced competition or predation. The microcosm system tested was found predation. The microcosm system tested was found suitable for long-term experiments, and could maintain a near-natural density of meiofauna and P. affinis for over one year. Such long-term experiments demonstrated effects of cadmium even at a concentration as low as 6 microgram/L, in the presence of sediment. (Author's abstract) W91-10519

FIELD SURVEY AND HYDRAULIC STUDY OF 'AOSHIO' IN TOKYO BAY.
National Inst. for Environmental Studies, Tsukuba

National History (Japan). K. Otsubo, A. Harashima, T. Miyazaki, Y. Yasuoka, and K. Muraoka. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 51-55, 1991. 6 fig, 2 tab, 5 ref.

Descriptors: \*Aoshio phenomenon, \*Eutrophication, \*Hydrogen sulfide, \*Japan, \*Marine pollution, \*Tokyo Bay, \*Upwelling, \*Water pollution effects, Anoxic conditions, Model studies, Remote sensing, Wind effects.

The color of the sea surface changes to milky-blue and many fish and shellfish are killed when the 'blue tide', or 'aoshio' phenomenon occurs. Aoshio 'blue tide', or 'aoshio' phenomenon occurs. Aoshio has appeared only in the summer and only in a particular eutrophic coastal area of Tokyo Bay in Japan. Field surveys at the sea surface by ship and from the air via helicopter assessed the aoshio phenomenon physicochemically and biologically. Aoshio is believed to be caused by a hydrogen-sulfide-containing anoxic bottom-water mass which develops off the coast in the summer. This water upwells in the coastal area when offshore winds blow for several days in a row. Before reaching the surface, the dissolved hydrogen sulfide is oxidized to colloidal sulfur particles. The fide is oxidized to colloidal sulfur particles. The milky-blue color is attributed to the random reflection of sunlight off these particles. Numerical simution of suming to it trees particles. Numerical simulations using two-dimensional equations for stratified flow were used to explain the water-mass ascent. (Brunone-PTT) W91-10529

IMPACT OF NUTRIENT ENRICHMENT AND THEIR RELATION TO THE ALGAL BLOOM IN THE ADRIATIC SEA.

Institute of Oceanography and Fisheries, Split

institute of Oceanography and Fisheries, Spitt (Yugoslavia). I. Vukadin. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 145-148, 1991. 4 tab, 8 ref.

Descriptors: \*Adriatic Sea, \*Algal blooms, \*Enrichment, \*Eutrophication, \*Nutrient concentrations, \*Path of pollutants, \*Water pollution effects, Estuaries, Industrial wastes, Municipal wastes, Runoff, Stratification.

Extraordinary manifestations of eutrophication in the Adriatic Sea during the last few years have been due to the combined effects of different physbeen due to the combined effects of different phys-icochemical and meteorological factors. Perma-nent inputs of nutrients, particularly in the north-ern Adriatic via river runoffs and municipal sewage during calm summers, cause marked strati-fication of the water column and reduction of horizontal advection. These two effects provide the ideal conditions for a single species bloom.

Calculation of the nutrient balance provides a better explanation of algal blooms in the Adriatic, better explanation of algal blooms in the Adriatic, showing that the source of nutrient input is the northern Adriatic in front of the Po River estuary and the estuaries of other northern Italian rivers. These river runoffs and industrial wastes are the source and direct cause of eutrophication and algal lacense while metacorological and hydrological blooms, while meteorological and hydrological conditions support the spreading and persistence of the bloom in the northern and middle Adriatic. (Brunone-PTT)

W91-10544

LIFE CYCLE STRATEGIES OF THE RED TIDE CAUSING FLAGELLATES CHATTONELLA (RAPHIDOPHYCEAE) IN THE SETO INLAND

ei Regional Fisheries Research Lab., Hiroshima (Japan).
For primary bibliographic entry see Field 5B.
W91-10546

CHANGES AND STRESS SIGNS IN PLANK-TON COMMUNITIES AS A RESULT OF MAN-INDUCED PERTURBATIONS IN ENCLOSED BALTIC).

secnnion - Israel Inst. of Tech., Haifa. Faculty of Agricultural Engineering. B. Kimor. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 171-174, 1991.

Descriptors: \*Baltic Sea, \*Coastal waters, \*Eutrophication, \*Marine pollution, \*Mediterranean Sea, \*Plankton, \*Species composition, \*Water pollution effects, Algal blooms, Dam effects, Enrichment, Fishkill.

Eutrophication induced by nutrient enrichment in coastal waters stimulates development of phyto-plankton blooms with frequently deleterious effects to marine life. A number of case histories are found in the land-locked Mediterranean and Baltic Seas. Among them is the recent occurrence of the potentially toxic dinoflagellate Prorocentrum minimum in the Adriatic and Kiel Fjord and of the prymnesiomonad Chrysochromulina polylepis associated with fish kills in the Baltic. Other changes affecting the periodicity of the algal blooms with drastic effects on coastal fisheries have been reported from the Levant Basin following the activation of the Aswan High Dam on the Nile. An extensive before and after monitoring program is proposed for particularly vulnerable areas aimed at the denot particularly vulnerable areas aimed at the de-tection of stress signs manifested by subtle or abrupt changes in species composition and a down-shift in the size of phytoplankton components. Implementation of modern field and laboratory technologies, along with a better understanding of organismic biology can be used to complement one another for an effective monitoring program in the coastal waters of coastal seas. (Author's abstract) W91-10547

BLOOM OF COSCINODISCUS WAILESII AND DO DEFICIT OF BOTTOM WATER IN SETO INLAND SEA.

Hyogo Prefectural Fisheries Experimental Station, Akashi (Japan).

T. Manabe, and S. Ishio.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 181-184, 1991. 11 fig.

Descriptors: \*Algal blooms, \*Diatoms, \*Eutrophication, \*Oxygen deficit, \*Population dynamics, \*Seto Inland Sea, \*Water pollution effects, Biological pollution, Dissolved oxygen, Japan, Temperature effects, Transparency, Water pollution

Relationships among high Secchi disk visibility values, dissolved oxygen deficits in bottom water layers, and a bloom of the giant diatom Coscinodislayers, and a forth of the giant thatom cost mous-cus wallesii were investigated in eastern Seto Inland Sea (SIS), Japan. C. wailesii first appeared in autumn when water temperatures went down, utilizing high levels of nutrients to build its popula-tion density. Decline of the algal bloom created a applied position of algal remains onto the bottom mud. Consequently, Secchi disk visibility increased in the area and the phytoplankton cells continued to decompose in the sediment. During the winter, with low water temperatures the organic matter remained in the sediment, while with higher water temperatures the organic matter broke down. The cause of the recent dissolved oxygen deficit of the bottom water in SIS was the decomposition of the giant diatom population in the sediment, accelerated by the increased bottom water temperature. (Author's abstract)

W91-10549

LONG TERM ECOLOGICAL CHANGES IN THE GULF OF THAILAND. Department of Fisheries, Bangkok (Thailand). Marine Fisheries Div.

For primary bibliographic entry see Field 5B. W91-10551

BENTHIC FAUNAL SUCCESSION IN A COVE ORGANICALLY POLLUTED BY FISH FARM-ING.

Kumamoto Women's University, Mizuarai 2432-1, Kengun-machi, Kumamoto, 862 Japan. H. Tsutsumi, T. Kikuchi, M. Tanaka, T. Higashi, and K. Imasaka.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 233-238, 1991. 8 fig, 17 ref.

Descriptors: \*Coastal areas, \*Fish farming, \*Fisheries, \*Japan, \*Path of pollutants, \*Sediment contamination, \*Water pollution effects, \*Water pollution tamination, "water poliution effects," water poliu-tion sources, Anoxic conditions, Aquaculture, Benthos, Bottom water, Decomposition, Life cycles, Organic matter, Population density, Sedi-ment chemistry, Species diversity, Succession, Tomoe Cove.

In the past two decades, a fish farming industry using net cages has developed in the coastal waters throughout Japan. Such fish farming has allowed the production of large amounts of valuable fish and their supply to the markets in major cities on a regular basis. However, fish farming is often accompanied by serious organic pollution of the water and increased bottom sediment in the vicinity of the cages, since approximately 90% of the food for the fish results in organic discharge to the environment around the fish farm. Organic pollution of soft bottom sediment is often accompanied environment around the instram. Organic politi-tion of soft bottom sediment is often accompanied by the development of reducing conditions in the sediment and deoxidation of the bottom water, as a result of the decomposition of abundant organic matter. The benthic communities in organically polluted areas are subject to catastrophic environ-mental disturbances. Results of surveys in Tomoe Cove, Kyushu, Japan show dramatic changes in fauna and reduction in abundance of members of Tauna and reduction in abundance of members of the benthic communities as a result of organic pollution accompanying fish farming. Dominant species tend to be those with short life cycles and high potential for population growth, to quickly colonize these polluted areas. (Author's abstract)

EFFECTS OF OIL POLLUTION ON BIO-ECOLOGY AND FISHERIES ON CERTAIN ENCLOSED COASTAL REGIONS OF ARABI-

Marine Products Export Development Authority, Cochin (India). For primary bibliographic entry see Field 5B. W91-10555

ECOLOGICAL MODELLING AT OSAKA BAY RELATED TO LONG-TERM EUTROPHICA-TION.

Japan NUS Co. Ltd., Tokyo. T. Doi, and A. Nitta. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 247-252, 1991. 1 fig, 1 tab, 5 ref.

tors: \*Ecosystems, \*Eutrophication, \*Mathematical models, \*Model studies, Descriptors: \*Japan, \*Mathematical models, \*Notes: Biomass, \*Osaka Bay, \*Water pollution effects, Biomass, Comparison studies, Crabs, Cuttlefish, Fish physical Flatfish, Inorganic matter, Mantis ology, Fisheries, Flatfish, Inorganic matter, Mantis shrimp, Phosphorus, Seabasses, Species diversity.

Based upon the Andersen and Ursin ecological model, an adequate model was constructed to evaluate quantitatively the overall impact of industrial large-scale development on fisheries at Osaka Bay. The model treats quantities of phosphorus as index of biomass of each species as well as mass of inorganic matter, converted by phosphorus equiva-lent. The model must consist of simultaneous differential equations to describe the ecosystem, be-

### Group 5C-Effects Of Pollution

cause of the high number of physical and biological components of the system. Twenty-three species, selected from more than eighty species of commercial fish, were used in the analysis. The patterns of changes in biomass of dominant species, which is caused by eutrophication, can be explained by the model. Verification of the model was accomplished by comparing the calculated was accomplished by comparing the calculated panied by the model. Verification of the model was accomplished by comparing the calculated results with the actual changes of catch and body weight over time. The simulated results for two years, 1956 to 1957, are, on average, comparable to the actual variations, However, the results for several species, including sea bass, flat fish, crab, mantis shrimp, and cuttlefish, differ significantly from observed data, attributed to the lack of accurate parameters of anabolism and catabolism for younger-aged stages of these species. (Brunone-PTT) W91-10556

SIMULATION OF BIOECOLOGICAL AND WATER QUALITY PROCESSES IN EN-CLOSED COASTAL SEAS. Halcrow (William) and Partners, Swindon (Eng-

Jang, D. E. Reeve, C. R. Hoggart, and S. R. Brown. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 259-263, 1991. 3 fig, 11 ref.

Descriptors: \*Algal growth, \*Coasts, \*Eutrophica-tion, \*Marine pollution, \*Mathematical models, \*Model studies, \*Path of pollutants, \*Water pollu-tion effects, \*Water quality, Anoxic conditions, Computer programs, Hydrodynamics, Microorganentation, Solute transport

In enclosed marine waters, eutrophication often leads to prolific growth of algae, an accumulation of sediments, and the onset of anaerobic conditions of sediments, and the onset of anaerobic conditions following the death and decay of plant species. A restoration program may have to run over many years, so that any mathematical model capable of providing reliable long-term predictions must run in a fraction of real time. On the other hand, short term water quality changes are also of interest, such as the decay of bacteria discharged from a such as the decay of bacteria discharged from a sewage outfall. Environmental management can be split into the following categories: short-term phe-nomena, such as algal blooms and accidentar leases of toxic chemicals; longer-term phenomena, lasting several years; and combinations of the two fundamental components: a hydrodynamic/solute rangamental components: a hydrodynamic/solute transport model, and an ecological process model. Both models have been installed on personal com-puters. The ecological process model can produce a one year prediction in approximately seven min-utes per box. Both models have been validated against extensive experimental data sets, and have been used in coastal management projects. (Brun-

MARICULTURE AND EUTROPHICATION IN

JINHAE BAY, KOREA.

Department of Aquaculture, Tong-yeong Fisheries
Technical College, Chungmu 650-160, Korea.
For primary bibliographic entry see Field 5B.
W91-10558

STUDIES ON THE SITUATION OF POLLU-TION AND COUNTERMEASURES OF CON-TROL OF THE OCEANIC ENVIRONMENT IN ZHOUSHAN FISHING GROUND: THE LARG-EST FISHING GROUND IN CHINA. nental Sciences.

of Environ

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 281-288, 1991. 4 fig, 2 tab, 2 ref.

Descriptors: \*China, \*Coastal waters, \*Fisheries, \*Marine pollution, \*Wastewater pollution, \*Water pollution effects, \*Water pollution sources, \*Yangtze River, Bioaccumulation, Caoe River, Fish migration, Hangzhou Bay, Qiantang River, Species diversity, Toxicity, Trace metals, Yong River.

Zhoushan fishing grounds are located in the east-ern part of Hangzhou Bay, China, close to the

shoreline of Zhejiang Province and the Shanghai Municipality and encompassing areas of the Yangtze River, Qiantang River, Yong River, and Caoe River. The continental coastline is 1500 km in length, with a total area of fishing of about in length, with a total area of fishing of about 100,000 sq km, and is a spawning ground for various fish, shrimp, and crabs. The most abundant species are hairtail, larger yellow croaker, little yellow croaker, and cuttlefish. The annual catch is yellow croaker, and cuttlenist. In eannual catch is about 800 thousand tons, one-third of the national total. Lately, however, the annual catch has been reduced, dropping to 50% of former levels. Besides overfishing, the oceanic environment has become increasingly polluted. With the most developed coastline in China, wastewater discharge into the fishing grounds is as high as two billion. into the rishing grounds is as fight as two billion tons, causing serious organic pollution and levels of trace metals (Cu, Zn, Pb, and Cr) violating environmental standards. This pollution directly affects the structure and stability of oceanic ecosystems, changing migration routes of fishes and continuous from examinar properties. emigration from spawning grounds, and continual-ly increasing levels of residual toxins in aquatic products. These problems have been brought to the attention of the Chinese government, and measures are under way to improve the oceanic environmental quality. (Author's abstract) W91-10559

INCIDENCE AND ECOLOGY OF MARINE FOULING ORGANISMS IN THE EASTERN HARBOUR OF ALEXANDRIA, EGYPT.
Institute of Oceanography and Fisheries, Alexan-

dria (Egypt). M. M. El-Komi.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 289-296, 1991. 2 fig, 3 tab, 10 ref.

Descriptors: \*Alexandria, \*Biofouling, \*Coastal waters, \*Egypt, \*Marine pollution, \*Wastewater pollution, \*Wastewater pollution, effects, Abundance, Algae, Alkalinity, Amphipods, Ascidians, Barnacles, Bryozoans, Dissolved oxygen, Fouling, Hydroids, Juvenile growth stage, Polychaetes, Seasonal variation, Seawater, Species diversity, Sponges, Water temperature

The Eastern Harbour of Alexandria is a relatively small semi-circular polluted bay, covering an area of about 2.8 sq km. The seasonal changes, intensity and components of fouling on exposed test panels and components of routing on exposed test panels for short-term and long-term intervals were investigated in relation to prevailing environmental conditions in the Eastern Harbor from March 1984 to March 1984. The intensity of fouling on exposed test panels for long durations is considerably more dense than total fouling biomass on exposed panels with short-term exposure during the same period. The fouling colonies on the submerged panels reached a saturation point after three to six months. During the period of investigation, a total of 41 species of sedentary marine fouling organisms were noted. These species mainly belonged to eight main fouling groups: barnacles, serpulid tube worms, ascidians, bryozoans, amphipods, hydroids, algae, and sponges. The inflow of 36,000 cu m/day of untreated sewage into the harbor shows seasonal of ultracted swage into the nation's single seasonal fluctuations in the environmental conditions, particularly the dissolved oxygen, oxidizable oxygen, and alkalinity of seawater. The presence of fouling larval stages in plankton samples throughout most of the year did not demonstrate the actual settleof the year did not demonstrate the actual settlement intensity of fouling organisms, but the settling plate experiments did. Water temperatures affected the distribution of marine organisms and their abundance. (Brunone-PTT) W91-10560

FORMATION OF OXYGEN-DEFICIENT WATER MASS IN OMURA BAY.

NASS IN UMUKA BAY, Nagasaki Prefecture Inst. of Health Science and Envirnomental Science (Japan). For primary bibliographic entry see Field 5B. W91-10592

COAL MINE WATERS AND THEIR INFLU-ENCE ON THE PURITY ECOLOGICAL STATE OF RIVER AND THE FISH PRODUCTION, Akademia Rolnicza, Lublin (Poland). Dept. of Zo-ology and Hydrobiology.

For primary bibliographic entry see Field 5B.

WATERBORNE DISEASE OUTBREAK.

National Bacteriological Lab., Stockholm Y. Andersson.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 13-15, 1991. 2 fig.

Descriptors: \*Disinfection, \*Drinking water, \*Epi-Descriptors: "Disintection, "Drinking water, "Epidemiology, "Human diseases, "Sweden, "Water pollution sources, "Water quality monitoring, "Water treatment, Chlorination, Contamination, Fecal bacteria, Hydrogen ion concentration, Legislation, Public health, Water pollution effects.

Between 1980 and 1989, 63 waterborne disease outbreaks were reported in Sweden, with a total of 32,250 known cases. These outbreaks range from small household incidents to community outbreaks with thousands of victims. The largest outbreak occurred in 1988 in Boden, a city in the very north of Sweden with 26,000 inhabitants and a military camp with about 1,000 soldiers at risk. Beginning March 24, an estimated total of 10,700 (41%) of the march 24, an estimated total of 10,000 (41%) of the inhabitants and 341 (34%) of the soldiers fell ill with gastrointestinal symptoms. Investigations revealed that the tap water was bacteriologically similar to untreated raw water, showing moderate degrees of fecal contamination. It was disclosed that during the installation on March 22 of an electronic control extens for water treatment, the electronic control system for water treatment, the water treatment plant's chlorination and monitoring systems were out of order, and that rapid sand filtration had been the only water treatment. The shape of the epidemic curve resembled that of a common source outbreak. The duration of sympcommon source outbreak. The duration of symptoms ranged from less than one day to more than 20 days. Most people were ill one to three days. A new (January 1990) drinking water act provides stricter controls over microbiological and chemical sampling of raw and tap water and the monitoring of pH and chlorination. (See also W91-10612) (Doria-PTT) W91-10615

## THAMES WATER'S EXPERIENCES WITH CRYPTOSPORIDIUM.

Thames Water Authority, Reading (England). M. Poulton, J. Colbourne, and P. J. Dennis. Water Science and Technology WSTED4, Vol. 24, No. 2, p 21-26, 1991. 2 fig, 12 ref.

Descriptors: \*Cryptosporidium, \*England, \*Epidemiology, \*Human pathogens, \*Parasites, \*Protozoa, \*Public health, \*Thames River, \*Water pollution effects, \*Water pollution sources, \*Water treatment, Cattle, Contamination, Effluents, Farm wastes Tributaries

In February 1989, an outbreak of waterborne cryptosporidiosis associated with contaminated surface water in the upper Thames catchment was identified. Less than 0.01% of the population suffered symptoms sufficient for them to seek medical advice. Nevertheless, the impact of the outbreak on the community and the water undertakers was considerable, and an expert committee was appointed to advise on research and measures to control the disease and prevent future waterborne outbreaks. One of the committee's interim recommendations was to gather information on the occurrence of cryptosporidium oocysts in the aquatic environment, particularly sources used for abstrac-tion and production of drinking water. The origin of the contamination incidents recorded at Far-moor reservoir and the River Tillingbourne are still unclear. However, in the latter case agriculturall input is strongly suspected because the river receives no sewage effluent. Much of the area adjacent to the river is used as pasture for cattle. adjacent to the river is used as pasture for cattle. During the outbreak investigation in Swindon and Oxford, there was epidemiological evidence of the involvement of a tributary of the River Thames, which also receives minimal sewage effluent. (See also W91-10612) (Doria-PTT) W91-10617

### Effects Of Pollution—Group 5C

PROSPECTIVE EPIDEMIOLOGICAL STUDY OF DRINKING WATER RELATED GASTROIN-TESTINAL ILLNESSES.

Institut Armand-Frappier, Laval (Quebec). For primary bibliographic entry see Field 5B. W91-10618

DEVELOPMENT OF RISK ASSESSMENT METHODOLOGY FOR LAND APPLICATION AND DISTRIBUTION AND MARKETING OF MUNICIPAL SLUDGE.

Environmental Protection Agency, Washington, DC. Office of Research and Development. For primary bibliographic entry see Field 5E. Wal. 1078

ATRAZINE HAZARDS TO FISH, WILDLIFE, AND INVERTEBRATES: A SYNOPTIC REVIEW.

Patuxent Wildlife Research Center, Laurel, MD.

Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-204671. Price codes: A04 in paper copy, A01 in microfiche. Biological Report 85(1.18), Contaminant Hazard Reviews Report No. 18, May 1989. 53p, 7 tab, 119

Descriptors: \*Atrazine, \*Fish, \*Herbicides, \*Invertebrates, \*Literature review, \*Path of pollutants, \*Water pollution effects, \*Wildlife, Agriculture, Bioaccumulation, Birds, Ecological effects, Ecotoxicology, Mammals, Organic compounds, Toxicity

The herbicide atrazine is the most heavily used agricultural pesticide in North America. Domestically, more than 50 million kg are applied yearly to more than 25 million ha, primarily to control weeds in corn and sorghum crops. Atrazine residues have been detected in runoff from treated fields in lakes and streams at phytotoxic levels. Birds and mammals were comparatively resistant, with a low probability for atrazine accumulation and retention. Data are lacking on indirect effects of atrazine on wildlife granivores and insectivores. Direct effects to aquatic fauna occur at 94 microgm/L, and higher; however, indirect effects may occur at 20 microgm/L, and higher, partly through reduction of the food supply of herbivores, and partly through loss of macrophyte habitat. Bioaccumulation of atrazine is limited, and food chain biomagnification is negligible in aquatic ecosystems. Birds are comparatively resistant too atrazine, having a low probability for uptake and retention. Known acute oral LD-50 values for birds are > 2,000 mg/kg body weight, and dietary LD-50s are > 5,000 mg/kg ration. However, indirect ecosystem effects of atrazine on seed-, and insect-eating birds are unknown, and should be investigated. Data are lacking for atrazine toxicity to mammalian wildlife, but tests with domestic livestock and small laboratory animals indicate that this group is also comparatively resistant. Acute oral LD-50s for mammals > 1,750 mg/kg body weight, and dietary levels of 25 mg/kg (about 1.25 mg/kg body weight) and, for some species, 100 mg/kg body weight and, for some species, 100 mg/kg ter. Proposed criteria for aquatic life protection include < 5 microgm atrazine/L for sensitive species of aquatic flora, and < 11 microgm/L for most species of aquatic flora, and < 11 microgm/L for most species of aquatic flora, and < 11 microgm/L for most species of aquatic flora, and continual than the protection, although it has been suggested that < 7.5 microgm/L in drinking water, and < 0.0375 mg atrazine/kg body weight would pose

PRELIMINARY DATA SUMMARY FOR THE PHARMACEUTICAL MANUFACTURING POINT SOURCE CATEGORY.

Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards. For primary bibliographic entry see Field 5B. W91-10710

PRELIMINARY DATA SUMMARY FOR THE PAINT FORMULATING POINT SOURCE CATEGORY.

Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards. D. Williams.

D. Williams.

Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-126475. Price codes: A05 in paper copy, A01 in microfice. Report No. EPA/440/1-89/050, September 1989. 146p, 9 fig, 21 tab, 9 ref, 6 append. EPA Contract Nos. 68-03-3412, 68-03-3548 and 68-03-3339.

Descriptors: \*Industrial wastewater, \*Paint industry, \*Path of pollutants, \*Water pollution effects, Benzidine, Dichloromethane, Environmental effects, Mercury, Public health, Publicly owned treatment works, Water quality, Zinc.

The Hazardous and Solid Waste Amendments of 1984 (HSWA) to the Resource Conservation and Recovery Act (RCRA) required EPA to submit a report to Congress concerning those substances identified or listed under Section 3001 of HSWA which are not regulated under this subtitle by reason of the exclusion for mixtures of domestic sewage and other wastes that pass through a sewer system to a publicly owned treatment works (POTW). It has been recommended that additional research, data collection, and analysis be conducted to fill paint formulating industry information gaps concerning the sources and quantities of hazardous waste constituents and their effects on POTWs and the environment. The purpose of this study was to gather information to assist the Agency in deciding whether to develop national effluent limitations guidelines and standards for the industry. The document comprises three studies, undertaken independently, listed as follows: a technical support study; an economic impact study; and an environmental impact study. The environmental impact study was three studies of discharges from four indirect paint plants on POTWs and ultimately on the POTWs' receiving streams. Receiving stream impacts were evaluated by comparing estimated instream pollutant concernations with aquatic life toxic effects levels and EPA Water Quality Criteria developed for human health and aquatic life toxic effects levels and EPA Water Quality Criteria developed for human health and aquatic life toxic effects levels and EPA Water Quality Criteria developed for human health and aquatic life toxic effects levels and EPA water Quality Criteria developed for human health and aquatic life toxic effects levels and EPA water Quality Criteria developed for human health and aquatic life toxic effects levels and EPA water Quality Criteria developed for human health and aquatic life toxic effects levels and EPA water Quality impacts were projected to be minimal. Only two of the 64 evaluated pollutants (benziele to exceed human health criteria at b

SPECIES COMPOSITION OF FISH COMMUNITIES IN NORTHERN WISCONSIN LAKES: RELATION TO PH.

National Fisheries Research Center, La Crosse,

WI. J. G. Wiener, P. J. Rago, and J. M. Eilers. Available from the National Technical Information Service, Springfield, VA 22161, as PB90-132457. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-89/259, 1989. IN: Early Biotic Responses to Advancing Lake Acidification, Butterworth Publishers, Boston. (1988) 17p, 3 fig, 6 tab, 25 ref.

Descriptors: \*Acid rain, \*Hydrogen ion concentration, \*Lake fisheries, \*Limnology, \*Species composition, \*Species diversity, \*Water pollution effects, \*Wisconsin, Acid neutralizing capacity, Acidic lakes, Calcite, Ecosystems, Lakes.

Recent investigations of surface water and precipitation chemistry have aroused considerable concern about the potential effects of acidic precipitation on aquatic ecosystems in the north-central United States. The mean weighted pH of precipitation at two monitoring stations in north-central Wisconsin during 1980, was 4.45 and 4.63, or about 10-14 times, more acidic than normal rainfall—a

theoretical pH of 5.6. Many watersheds in northern Wisconsin have acid soils with low buffering capacities. Consequently, the water of most lakes in these watersheds is very soft and slightly acidic. Analyses of 275 northern Wisconsin lakes during 1979, indicated that 36% of the lakes were susceptible to acidification from acid precipitation as judged by the calcite saturation index; hydrologic type was a major factor affecting susceptibility. Fish communities in circumneutral Wisconsin lakes contained significantly more species than did those in acidic lakes. Common as well as rare fish species occurred with lower frequency in acidic lakes than circumneutral lakes. Differences in species composition and richness of fish communities between acidic and circumneutral lakes did not appear to be related to differences in physical habitat characteristics, past fish migrations or productivity between the two lake groups. Hydrogen ion concentration and related water chemistry characteristics strongly influenced the species composition and richness of fish communities in the lakes. (Lantz-PTT)

COMPREHENSIVE COOLING WATER STUDY, FINAL REPORT. VOLUME I: SUM-MARY OF ENVIRONMENTAL EFFECTS. Savannah River Lab., Aiken, SC. Environmental

Sciences Div.
For primary bibliographic entry see Field 5B.
W91-10729

APPLICATION OF A HAZARD ASSESSMENT RESEARCH STRATEGY TO THE OCEAN DIS-POSAL OF A DREDGED MATERIAL: OVER-

Environmental Research Lab., Narragansett, RI. For primary bibliographic entry see Field 5E. W91-10740

HEALTH RISK ASSESSMENT OF TOLUENE IN CALIFORNIA DRINKING WATER.

California Univ., Davis. Dept. of Environmental

Toxicology. R. Reed, W. Reed, L. Beltran, R. Li, and I. Encomienda.

Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-190383. Price codes: A07 in paper copy, A01 in microfiche. Report No. UCD/ET-89/1, March 1989. 133p, 4 fig. 16 tab, 280 ref. State of California Dept. of Health and University of California Interagency Agreement 87-87088.

Descriptors: \*California, \*Drinking water, \*Groundwater pollution, \*Path of pollutants, \*Public health, \*Toluene, \*Water pollution effects, Bioaccumulation, Literature review, Toxicity.

Toluene is used as an octane booster in gasoline and as a solvent base for a number of products. Volatilization from gasoline via spillage and auto exhaust is the principal means by which toluene is released into the environment. The doses of toluene received by populations in California (CA) from water-based sources are difficult to assess because of insufficient data. Three exposure pathways are used to estimate the total dose of toluene received by individuals in dwellings with contaminated tap water: ingestion, inhalation, and dermal contact. Exposure via the three pathways was used to calculate a daily time-weighted lifetime dose factor. Based on groundwater occurrence data on toluene, the estimated total exposed population in California is 25,283, and the estimated average dose per exposed person is 0.00014 mg/kg/d. The three main aims of this document are: (1) to review the existing literature pertinent to the health risk posed by the use of toluene-contaminated drinking water; (2) to estimate the toluene exposure of CA residents based on the most recent data on toluene concentrations in CA drinking water supplies; and (3) to delineate the concentration of toluene in description of the physical and chemical properties of toluene, and its use, environmental fate, and occurrence in CA drinking water. Information regarding absorption, distribution, accumulation, ex-

### Group 5C-Effects Of Pollution

cretion, and mechanisms of toxicity is summarized in Chapter 3. Chapter 4 contains estimates of daily doses that CA residents may receive through oral, dores that CA residents may receive through oran dermal, and inhalation exposures as a result of using toluene-contaminated drinking water. Chap-ters 5 and 6 provide a detailed description of the toxic effects of toluene in model biological systems and in humans to identify the hazards associated with toluene exposure. Chapter 7 presents the no observed adverse effect levels (NOAELs) and lowest observed adverse effect levels (LOAELs) for toluene based on data from acute, subchronic, and chronic toxicity studies in animals and humans. (Lantz-PTT) W91-10741

URBAN STORM-INDUCED DISCHARGE IM-

Environmental Protection Agency, Edison, NJ. Storm and Combined Sewer Technology Branch. For primary bibliographic entry see Field 5B. W91-10745

ASSESSMENT OF THE SALINITY TOLER-ANCE OF EIGHT SONORAN DESERT RIPARI-AN TREES AND SHRUBS. Nevada Univ. System, Reno. Desert Research Inst. For primary bibliographic entry see Field 3C. W91-10752

CONFIRMATORY CHEMICAL ANALYSES AND SOLID PHASE BIOASSAYS ON SEDI-MENT FROM THE COLUMBIA RIVER ESTU-

MENI FROM THE COLUMBIA RIVER ESTU-ARY AT TONGUE POINT, OREGON. Battelle Pacific Northwest Labs., Sequim, WA. Marine Research Lab. For primary bibliographic entry see Field 5B. W91-10753

DRINKING WATER CRITERIA DOCUMENT ON XYLENE.

Environmental Protection Agency, Cincinnati, OH. Environmental Criteria and Assessment

Office. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-192314. Price codes: A09 in paper copy, A01 in microfiche. June 1987. 198p, 16 tab, 155 ref.

Descriptors: \*Drinking water, \*Path of pollutants, \*Public health, \*Water pollution effects, \*Xylenes, Biodegradation, Model studies, Organic com-pounds, Toxicity, Volatilization.

Xylene is a dimethylbenzene which occurs in three position isomers: 0-, m-, and p-xylene. Mixed xylene is usually a mixture of the isomers and ethylbenzene. The half-life of xylene in water is about 6 hours, depending on depth, and loss is primarily by evaporation. Xylenes are soluble in water at approximately 175-200 mg/L at environmental temperatures, and the log octanol/water partition coefficients for the isomers range from 2.77 (o-xylene) to 3.20 (m-xylene). In surface waters, xylene volatilization appears to be the dominant removal process, as predicted by an EXAMS model. The volatilization half-lives calculated by the model range from 2.6-11.2 days. Oxi-Xylene is a dimethylbenzene which occurs in three lated by the model range from 2.6-11.2 days. Oxidation does not appear to be significant, nor does photolysis, since the xylenes do not absorb light significantly at wavelengths > 300 nm. Sorption significantly at wavelengths > 300 nm. Sorption will occur, accounting for varying accumulations in the sediments (4.5-70% of the total xylene load from the EXAMS model). Biodegradation may be significant, but appears to be highly variable. A number of experimental studies have been conducted on the toxicity of xylene in humans. A level of near 100 ppm (434 mg/cu m) for about 8 hours/ day for up to 5 days appears to be near a no-effect level for eye and throat irritation. At levels near 300-400 ppm (1300-1730 mg/cu m), reaction time, body balance and dexterity become affected. Most ody obtained and dexterity become affected. Most of the toxic effects of xylene are attributable to the parent compound, but minor metabolites, methylbenzaldehyde and arene oxides have been suggested as toxic intermediates. The appropriate toxicity data in laboratory animals and humans pertinent to the quantification of drinking water health advisory (HA) levels have been reviewed. Data were

insufficient for the derivation of 1-day and 10-day HAs for a child; therefore, the longer-term HA of 36 mg/L is recommended. The longer-term HA 36 mg/L is recommended. The longer-term HA values were determined from a no-observed-effect level in rats treated by gavage for 13 weeks. The values for an adult and a child are 125 and 36 mg/L, respectively. The lifetime HA or drinking water equivalent level (DWEL) was based on a no-observed-adverse-effect level in rats treated by gavage with 250 mg/kg/day, 5 days/week for 103 weeks. The calculated DWEL was 63 mg xylene/L. (Author's abstract) W91-10757

INHIBITION OF NO3(-), NH4(+), AND PO4(3-) UPTAKE IN ANABAENA DOLIOLUM EX-POSED TO A PETROLEUM OIL. North-Eastern Hill Univ., Shillong (India). Dept.

of Botany.

of Botany.
A. K. Singh, and J. P. Gaur.
A. K. Singh, and Environmental Ecotoxicology and Environmental Safety EESADV, Vol. 21, No. 2, p 103-108, April 1991. 4 fig. 19 ref.

Descriptors: \*Algae, \*Algal physiology, \*Cyanophyta, \*Nutrients, \*Oil pollution, \*Water pollution effects, Ammonium, Chlorophyll a, Mathematical models, Nitrates, Nutrient concentrations, Phos-

Algae and cyanobacteria are being increasingly exposed to high levels of petroleum pollution in aquatic environments. Earlier studies have shown reduced growth of these organisms upon exposure to this pollutant although in some cases, no harm-ful effects and even stimulation, was observed. The effects of petroleum on the kinetics of NO3(-), NH4(+), and PO4(3-) uptake in A. doliolum were analyzed. Assam crude was used as the test oil because its properties and action on other physio-logical processes of this cyanobacteris were stud-ied earlier by the same authors. The agreement ied earlier by the same authors. The aqueous ex-tract of Assam crude inhibited the uptake of these tract of Assam crude innioned the uptake of these compounds and the response was essentially concentration dependent. Inhibition was most severe for the uptake of NH4(+) followed in decreasing order by PO4(3-) and NO3(-). Uptake of nutrients was competitively inhibited and showed no change in V-max (50.64 nmol/microgram chlorophyll a/ hr), but apparent K-m was increased. It is concluded that certain oil components with unknown properties cause competitive inhibition of NO3(-), NH4(+) and PO4(3-) uptake in cyanobacteria. This can be alleviated by increasing the concentration of nutrients in the milieu. Therefore, inhibitory effects of petroleum on nutrient uptake may not pose a serious threat in eutrophic waters rich in nutrients. (Medina-PTT) W91-10825

INDUCTION OF BIOTRANSFORMATION IN THE LIVER OF EEL (ANGUILLA ANGUILLA L.) BY SUBLETHAL EXPOSURE TO DINITRO-O-CRESOL: AN ULTRASTRUCTURAL AND BIOCHEMICAL STUDY. Heidelberg Univ. (Germany, F.R.). Dept. of Zool-

Braunbeck, and A. Volkl.

Ecotoxicology and Environmental Safety EESADV, Vol. 21, No. 2, p 109-127, April 1991. 12 fig. 5 tab, 65 ref. Landesanstat fur Umwelts-chutz, Baden-Wurttemberg, Contract No. 12/

Descriptors: \*Biotransformation, \*Dinitro-ocresol, \*Eel, \*Liver, \*Microscopic analysis, \*Sub-lethal effects, Biochemical tests, Fish physiology, Fishkill,

Structural and functional alterations in hepatocytes of Anguilla anguilla, following a 4-week exposure to 5, 50, and 250 micrograms/liter dinitro-o-cresol (DNOC) were investigated by electron microscopy and biochemistry and compared to liver pathology in eels exposed to the chemical spill into the Rhine river at Basle (Germany) in November 1986. Whereas phenological parameters (growth, condition factor) were unaffected, ultrastructural and biochemical alterations were detectable at greater or equal to 50 and 5 micrograms/liter DNOC,

respectively. Structural modifications included: rounding-up of the nuclei; fractionation and reduc-tion of the rough endoplasmic reticulum; proliferation of the rough endoplasmic reticulum; proliferation of the smooth endoplasmic reticulum; proliferation of the smooth endoplasmic reticulum (SER),
mitochondria, peroxisomes, and lysosomes; bundles of rod-shaped SER profiles; annulate lamellae;
membrane whorls within mitochondria; crystallization of the peroxisomal matrix and glycogen
bodies; glycogen depletion and lipid augmentation.
Structural changes can be correlated to an increase
in hepatic lipid and protein contents as well as
stimulation of mitochondrial (cytochrome c oxidase), peroxisomal (catalase, allantoinase, uricase),
lysosomal (arylsulfatase), and microsomal (esterase) enzymes. An increase in NADPH-cytochrome
c reductase and cytochrome P450 as well as UDPglucuronyltransferase and aryl-sulfotransferase activities in the microsomal fraction document and
induction of hepatic biotransformation as a functional correlate to SER proliferation. Maximum tional correlate to SER proliferation. Maximum tional correlate to SER proliferation. Maximum inducibility of biotransformation enzymes at 50 microgram/liter indicates a biphasic, concentration-dependent reaction to eel liver. Comparison of DNOC-induced effects with liver pathology in eel exposed to the chemical spill in 1986 revealed striking similarities so that DNOC may not be excluded as a possible factor in the fish kill in the Rhine river. (Author's abstract) W91-10826

BIOCHEMICAL AND HISTOCHEMICAL OB-SERVATIONS ON EFFECTS OF LOW-LEVEL METAL LOAD (LEAD, CADMIUM) IN DIF-FERENT ORGAN SYSTEMS OF THE FRESH-WATER CRAYFISH, ASTACUS ASTACUS L. (CRUSTACEA: DECAPODA).

Tieraerztliche Hochschule Hannover (Germany, F.R.). Inst. fuer Zoologie. For primary bibliographic entry see Field 5B. W91-10827

EFFECT OF 3,4-DICHLOROANILINE ON THE EARLY LIFE STAGES OF THE ZEBRAFISH (BRACHYDANIO RERIO): RESULTS OF A COMPARATIVE LABORATORY STUDY.

Mainz Univ. (Germany, F.R.). Inst. fuer Zoologie. For primary bibliographic entry see Field 5A. W91-10828

ULTRASTRUCTURAL AND BIOCHEMICAL EFFECTS OF CADMIUM ON THE AQUATIC FERN MARSILEA MINUTA LINN.

Industrial Toxicology Research Centre, Lucknow (India). Ecotoxicology Section.
J. Singh, S. Devi, G. Chawla, M. Gupta, and P. N.

Viswanathan. Ecotoxicology and Environmental Safety EESADV, Vol. 21, No. 2, p 171-181, April 1991. 8 fig, 5 tab, 38 ref.

Descriptors: \*Bioassay, \*Cadmium, \*Ferns, \*Macrophytes, \*Phytotoxicity, \*Toxicity, \*Toxicology, \*Water pollution effects, Biocides, Electron microscopy, Microscopic analysis, Plant growth, Plant pathology, Tissue analysis.

Cadmium is a common water pollutant and its phytotoxicity, ecosystem effects, and accumulation in the food chain are environmental concerns. Aquatic macrophytes offer a convenient test system to study the uptake, translocation, and toxicity of metals under experimental conditions and for extrapolation to ecological field studies. Pterifor extrapolation to ecological field studies. Pteridophytes have received relatively little attention
from environmentalists, hence, the formation of
Cd-binding proteins in cultured vegetative clones
of the aquatic pteridophyte M. minuta was studied
in a static environmental bioassay system as a
function of dose and period of exposure. A transmission electron microscope used to determine the
pathomorphological manifestations of Cd toxicity
showed damage to chloroplasts and tonoplasts as
well as the presence of electron naque eranular snowed damage to chloroplasts and tonoplasts as well as the presence of electron opaque granular deposits. Preliminary evidence based on molecular sieving chromatography indicated the formation of two cadmium-binding proteins of 78 and 33 kilodaltons in the leaf tissue under cadmium stress. Dispersion of tannin bodies in the vacuoles could also be related to Cd treatment. Dose-dependent

### Effects Of Pollution—Group 5C

changes in the development and differentiation of the juvenile leaves and in the general growth pat-terns were also observed. (Medina-PTT) W91-10829

INITIAL EVALUATION OF DEVELOPMENTAL MALFORMATION AS AN END POINT IN MIXTURE TOXICITY HAZARD ASSESSMENT FOR AQUATIC VERTEBRATES.
Tennessee Univ., Knoxville. Coll. of Veterinary

Medicine

D. A. Dawson, and T. S. Wilke.

Ecotoxicology and Environmental Ecotoxicology and Environmental Safety EESADV, Vol. 21, No. 2, p 215-226, April 1991. 3 fig, 3 tab, 31 ref.

Descriptors: \*Biochemical tests, \*Frogs, \*Hazard assessment, \*Teratogenicity, \*Toxicity, \*Water pollution effects, Animal physiology, Chemical analysis, Embryonic growth stage, Enzymes.

The joint toxic action of three binary mixtures was determined for the embryo malformation endpoint of the aquatic FETAX (frog embryo teratogenesis assay: Xenopus) test system. This system was developed to evaluate chemicals for potential developmental toxicity and teratogenicity, and has appli-cations in aquatic toxicology as well as experimental teratology. Osteolathyrogenic compounds (iso-niazid and beta-aminopropionitrile) and short-chain carboxylic acids (valproic acid and butyric acid), representing separate, distinct modes of action for induction of malformation, were selected for testing in 96-hr, static-renewal tests. Three mixtures were tested for each combination, with each combination being tested on three separate occasions. Using toxic unit analysis, the combination of osteo-lathyrogens and the combination of carboxylic acids produced strictly additive (concentration addition) rates of malformation, while the combina-tion of an osteolathyrogen and a carboxylic acid was less-than-additive (response addition) for in-duction of malformation. Therefore, a develop-mental malformation endpoint may have value for toxicity hazard assessments, especially for ovipa-rous aquatic organisms which may begin organorous aquatic organisms which may begin organo-genesis before completely developing detoxifying enzyme systems. As many polluted freshwater sys-tems are contaminated by more than one undesir-able chemical, the ability to use developmental malformation as an end point in joint toxic action studies represents an additional approach for fur-thering hazard assessment in aquatic toxicology. a-PTT) (Medir

ACUTE AQUATIC TOXICITY OF ALKYL PHENOL ETHOXYLATES, Bayer A.G., Leverkusen (Germany, F.R.). G. Schuurnann.

Ecotoxicology and Environmental Safety EESADV, Vol. 21, No. 2, p 227-233, April 1991. 2 fig, 2 tab, 17 ref.

Descriptors: \*Bioindicators, \*Narcosis, \*Surfactants, \*Toxicity, \*Toxicology, \*Water pollution effects, Aquatic life, Crustaceans, Mathematical models, Organic pollutants, Regression analysis.

The recently derived log K-OW (octanol/water partition coefficient in logarithmic form) increment for a nonterminal oxyethylene (EO) unit was used to calculate a quantitative structure-activity relationship (QSAR) for literature data and the acute to the content of the conten crustacean toxicity of polyoxyethylene surfactants. The resulting log K-OW regression parameters are between the corresponding values for nonpolar and polar narcosis, which supports an interpretaand polar narcosis, which supports an interpreta-tion of the surfactants' aquatic toxicity on the basis of another distinct mode of action. Furthermore, a comparison with calculated water solubility data indicates that for log K-OW > 5 an aquatic toxici-ty decrease due to a solubility limit is expected, which supported by two other sets of toxicity data for nonyl phenol polyethoxylates. According to the present QSAR analysis, the acute aquatic toxic-ity of alkyl phenol ethoxylates can be understood on the basis of a distinct narcosis syndrome. Since on the basis of a distinct narcosis syndrome. Since this anesthetic mode of action also may be valid for other nonionic EO surfactants, the tentative name EO surfactant narcosis syndrome is proposed. Es-

tuarine crustacea appear to be an indicators of the general narcosis toxicity of organic pollutants. Therefore, they are useful as test species for screening purposes. (Medina-PTT) W91-10833

EFFECT OF PESTICIDE TREATMENTS ON NONTARGET ORGANISMS IN CALIFORNIA RICE PADDIES.
California Univ., Davis. Agricultural Experiment

Station.
A. A. Grigarick, R. K. Webster, R. P. Meyer, F. G. Zalom, and K. A. Smith.
Hilgardia HILGA4, Vol. 58, No. 1, p 1-36, August 1990. 7 fig. 8 tab, 37 ref.

Descriptors: \*California, \*Organotins, \*Pesticide toxicity, \*Pesticides, \*Rice, \*Toxicity, \*Water pollution effects, Aquatic populations, Benthos, Carniverse, Crustaceans, Ecological effects, Herbivores, Invertebrates, Mosquitoes, Shrimp, Species diversity. ty, Urea pesticides.

ty, Urea pesticides.

An application of triphenyltin hydroxide at 1.16 kg Al/ha (active ingredient per hectare) to rice fields for stem rot (Sclerotium oryzae) control resulted in a significant reduction of 57% of the invertebrate taxa and 67% fewer individuals based on two collecting methods that sampled the nekton, neustron, and benthos. Population of herbivores, carnivores and filter feeders were sharply reduced after treatment, and most remained so through the 28th day following application. By day 50 many of the winged species recovered in both numbers and diversity. However, recovery of benthic organisms was slower or not at all for most Crustacea. An initial reduction followed by a strong resurgence was noted for the mosquito Culex tarsalis, which was probably due to the significant reduction of the predaceous species. Two benzoylphenyl ureas, diflubenzuron and triflumuron, were evaluated in California rice fields to determine their ecological impact on populations of nontarget organisms. impact on populations of nontarget organisms.

Modified minnow traps, drag net, and kellen dredge sampling were used in the collecting. Nondredge sampling were used in the collecting. Non-target populations were sampled continuously throughout much of the 1985 and 1986 rice grow-ing season. Total collections of non-targets showed only two Cypris species of seed shrimp crustaceans were significantly (P<0.05) reduced over time due to either chemical. One predaceous water boat-nan, Corisella decolor, showed the opposite pat-tern in that populations were significantly (P<0.05) lower in the control. Significant differ-ences were not observed in species diversity or (15 < 0.02) lower in the control. Significant differences were not observed in species diversity or between treatments when grand means for all species by sampling device were calculated. A total of 35 families and 58 taxa were collected from these two studies. (Author's abstract)

DIOXIN CONTAMINATION AND GROWTH AND DEVELOPMENT IN GREAT BLUE HERON EMBRYOS.

British Columbia Univ., Vancouver. Dept. of Animal Science

Animal Science.
L. E. Hart, K. M. Cheng, P. E. Whitehead, R. M. Shah, and R. J. Lewis.
Journal of Toxicology and Environmental Health
JTEHD6, Vol. 32, No. 3, p 331-344, March 1991. 5
tab, 35 ref. Canadian Wildlife Service (DSS file no.
06SB. KR603-8-0017).

Descriptors: \*Canada, \*Dioxins, \*Pulp wastes, \*Toxicity, \*Toxicology, \*Water birds, \*Water pollution effects, Animal pathology, Biochemical tests, Eggs, Herons, Mortality, Regression analysis, Tissue analysis.

The reproductive success of great blue heron colonies on the Strait of Georgia, British Columbia (Canada), has been monitored since 1983. A colony of this bird near a pulp mill failed to fledge young in 1987, had a concurrent sharp increase in polychlorinated dibenzo-p-dioxin (PCCD) and polychlorinated dibenzo-p-dioxin (PCCD) levels in their eggs. In 1988, the hypothesis that the PCDD and PCDF contamination caused reproductive failure by increasing mortality of the heron embryos in ova was tested. Pairs of great blue heron eggs were collected from three British Columbia colonies

with low, intermediate, and high levels of dioxin with low, intermediate, and high levels of dioxin contamination: Nicomeki, Vancouver and Crofton, respectively. One egg of each pair was incubated under laboratory conditions at the University of British Columbia while the other egg was analyzed for PCCDs and PCDFs. All incubated eggs were fertile. All eggs from the Nicomeki colony hatched, while 13 of 14 eggs from Vancouver and 12 of 13 eggs from Crofton hatched. Subcutaneous edgma was observed in 4 of 12 chicks from Crofton of the process of th edema was observed in 4 of 12 chicks from Crofton and 2 of 13 chicks from Vancouver. No edema was seen in the chicks from Nicomeki. There was a was seen in the chicks from Nicomeki. There was a small, but significant, negative regression of plasma calcium concentration, yolk-free body weight, tibia length, wet, dry, and ash weight, beak length, and kidney and stomach weight of the hatched chicks with the tetrachlorodibenzo-p-dioxin (TCDD) level of the paired eggs. Fewer down follicles were present on the heads of TCDD-contaminated chicks. Hence while dioxins did not cause mortality of the hence surheve in over the depression. ty of the heron embryos in ovo, the depression of growth and the presence of edema are suggestive that dioxins at the levels found in the environment have an adverse effect on the development of great blue heron embryos. (Author's abstract)

SUBCHRONIC HEPATOTOXICITY OF SE-LENOMETHIONINE INGESTION IN MAL-LARD DUCKS

Patuxent Wildlife Research Center, Laurel, MD. D. J. Hoffman, G. H. Heinz, L. J. LeCaptain, and C. M. Bunck.

Journal of Toxicology and Environmental Health JTEHD6, Vol. 32, No. 4, p 449-464, April 1991. 4 fig. 1 tab. 46 ref. Bureau of Reclamation Fish and Wildlife Service interagency agreement 6-AA-20-

Descriptors: \*Biochemical tests, \*Ducks, \*Selenium, \*Tissue analysis, \*Toxicity, \*Toxicology, \*Water birds, \*Water pollution effects, \*Waterfowl, Animal pathology, Bioaccumulation, Blood, Liver, Mortality, Vegetation, Wildlife conserva-

Selenium (Se) can reach toxic levels in aquatic environments from leaching of agricultural soils, fly ash from coal-fired power plants, and mining of phosphates and metal ores. A study was designed to examine the effects in adult mallards (Anas platyrhynchos) of subchronic dietary exposure to release a form of Sa found in vaccinations. platyrnynchos) or subchrome chetary exposure to selenomethionine, a form of Se found in vegeta-tion. Two-year old male mallards received a con-trol diet (0.2 ppm Se) or diets containing 1, 2, 4, 8, 16, or 32 ppm Se as selenomethionine for 14 wk. Se accumulated readily in the liver in a dose-depend-16, or 32 ppm Se as selenomethionine for 14 wk. Se accumulated readily in the liver in a dose-dependent manner, reaching a mean concentration of 29 ppm (wet weight) in the 32 ppm group. Dietary Se of 2 ppm or greater increased plasma glutathione peroxidase activity. Mortality (10%) and histopathological effects, including bile duct hyperplasia and hemosiderin pigmentation of the liver and spleen, occurred in the 32 ppm group. These histopathological effects were accompanied by lower hemoglobin concentrations (16 and 32 ppm groups) and hematocrit (32 ppm group), and elevated plasma phosphatase activity (32 ppm group) indicative of cholestatic liver injury. Other manifestations of hepatotoxicity included significant linear dose responses for hepatic oxidized glutathione (GSSG) concentrations and ratio of GSSG to reduced glutathione (GSH). Means for both of these responses differed from control in groups receiving 8-32 ppm Se. Mean hepatic GSH and malondialdehyde (a measure of lipid peroxidation) concentrations were significantly elevated in the 16 and 32 ppm groups. Subchronic effects of selenomethionine, which occurs in vegetation, are of particular interest with respect to the health of wild aquatic birds in seleniferous locations. (Author's abstract) W91-10838 W91-10838

TRACE METAL INTERACTIONS WITH MARINE PHYTOPLANKTON.

National Marine Fisheries Service, Beaufort, NC. For primary bibliographic entry see Field 2L.

W91-10853

### Group 5C-Effects Of Pollution

EFFECTS OF PH AND ALUMINUM ON THE GROWTH OF THE ACIDOPHILIC DIATOM ASTERIONELLA RALFSII VAR. AMERICANA. Michigan Univ., Ann Arbor. Dept. of Biology. For primary bibliographic entry see Field 2H. W91-10862

MODIFICATION OF BENTHIC COMMUNITY STRUCTURE IN RESPONSE TO ACID-IRON WASTES DISCHARGE.

Marine Ecological Surveys Ltd., Faversham (England)

iana). R. C. Newell, D. W. Maughan, M. W. Trett, P. F. Newell, and L. J. Seiderer. Marine Pollution Bulletin MPNBAZ, Vol. 22, No. 3, p 112-118, March 1991. 6 fig, 20 ref.

Descriptors: \*Acidic water, \*Benthic fauna, \*Industrial wastewater, \*Iron, \*Quebec, \*South Africa, \*Wastewater pollution, \*Water pollution effects, Canada, Coastal waters, Invertebrates, Rivers, St Lawrence River, Titanium dioxide in-

Surveys of the impact of acid-iron wastes from the titanium dioxide industry on benthic community titanium dioxide industry on benthic community structure were carried out at a number of sites world-wide. Results are presented for an outfall into the freshwaters of the St. Lawrence River near Quebec, Canada and for an outfall into the coastal waters of the Indian Ocean near Durban, South Africa. The results suggest that it is the metallic components of the dispersing neutralized effluent, rather than acidity, which are responsible for changes in invertebrate community structure along the axis of dispersion wastes. This implies that elimination of biological impact may best be achieved by a reduction of trace metals either in the feedstock or by removal from the effluent stream. Previous surveys suggest that the concenstream. Previous surveys suggest that the concentrations of copper and manganese in the sediments have no consistent relationship with the zone of biological impact. The concentrations of zinc within the zone of biological impact; however, within the zone of biological impact; however, show a remarkable similarity in both marine and freshwater systems and indicate that values in excess of 250-300 mg/kg are associated with a modification of benthic community structure. Corresponding values for lead are 20-30 mg/kg, vanadium 40-60 mg/kg, chromium 70-100 mg/kg and iron 3.0-4.0 ppt. This suggests that these metallic residues have a relative impact of Pb > V > Cr > Zn > Fe, although there is no information at present on the extent of the impact which one or a present on the extent of the impact which one, or a combination of these metallic residues, is exerting on the benthic community structure. (Author's abstract) W91-10869

IMPACT OF TITANIUM DIOXIDE WASTE ON FERTILIZATION IN THE SEA URCHIN ECHINOMETRA MATHAKI. Council for Scientific and Industrial Research, Congella (South Africa). Estuaries and Freshwater

A. D. Connel, D. D. Airey, and P. A. Rathbone. Marine Pollution Bulletin MPNBAZ, Vol. 22, No. 3, p 119-122, March 1991. 2 fig, 4 tab, 13 ref.

Descriptors: "Acidic water, "Echinoderms, "Industrial wastewater, "Iron, "South Africa, "Titanium dioxide, "Toxicity, "Wastewater pollution, "Water pollution offects, Reproduction, Sperm, Titanium dioxide industry.

The acid content has long been targeted as the important component of acid-iron wastes from the titanium dioxide industry. However, numerous studies have shown the impact extends beyond the zone of reduced pH. A 10-minute sperm test, using zone of reduced pH. A 10-minute sperm test, using the gametes of the sea urchin Echinometra mathaei on components of a typical acid-iron effluent, showed that while the acid was rendered non-toxic at less than 5000 dilutions, the acid-iron mixture required in excess of 100,000 dilutions to render it non-toxic. Iron hydroxide caused clumping of the sperm, thus effectively inhibiting fertilization in seawater, with serious implications for all species practicing external fertilization. (Author's abstract) W91-10870 IMMUNOCHEMICAL DETECTION OF CY-TOCHROME P450IA1 INDUCTION IN COD LARVAE AND JUVENILES EXPOSED TO A WATER SOLUBLE FRACTION OF NORTH SEA CRUDE OIL,

Bergen Univ. (Norway). Dept. of Biochemistry. For primary bibliographic entry see Field 5A. W91-10871

EFFECTS OF LINEAR ALKYLBENZENE SUL-PHONATE (LAS) ON SKELETAL DEVELOP-MENT OF SEA URCHIN EMBRYOS (PARA-CENTROTUS LIVIDUS LMK), Padua Univ. (Italy). Dept. of Biology. M. Bressan, M. G. Marin, and R. Brunetti.

Water Research WATRAG, Vol. 25, No. 5, p 613-616, May 1991. 6 fig. 31 ref.

Descriptors: \*Animal growth, \*Detergents, \*Echinoderms, \*Linear alkyl sulfonates, \*Toxicity, \*Toxicology, \*Water pollution effects, Calcium, Chronic toxicology, Embryonic growth stage, Inhibition, Surfactants.

Linear alkylbenzene sulphonate (LAS) acts on the zygotes of the sea urchin Paracentrotus lividus, inducing total inhibition of skeletal development at concentrations higher than 0.45 ppm and a signifi-cant decrease at concentrations of 0.30 ppm. The effect of the surfactant is maximum at the end of gastrulation, when Ca uptake is very high, presum-ably related to the beginning of skeletal growth. This suggests that in the environment the sequestering action of LAS on Ca may significantly affect the availability of Ca for morphogenesis. Nevertheless, the experimental data suggest that the toxic action of LAS is also exerted at levels other than those involved in Ca uptake. (Author's W91-10891

ROLE OF PHOSPHORUS CYCLING IN ALGAL METABOLISM AND ALGAL SUCCES-SION IN LAKE DONGHU, CHINA.

Academia Sinica, Luojiashan (China). Inst. of Hydrobiology.

J. Wang, and J. K. Liu.

Archiv fuer Hydrobiologie AHYBA4, Vol. 120, No. 4, p 433-445, February 1991. 7 fig, 4 tab, 23

Descriptors: \*Algae, \*Eutrophication, \*Lakes, \*Limnology, \*Metabolism, \*Phosphorus, \*Water pollution effects, Algal blooms, Aquatic life, Biomass, \*China, Enrichment, Lake Donghu, Nutrients, Photosynthesis, Success

The role of phosphorus cycling in algal metabolism was studied in shallow Lake Donghu in Wuhan, China, using the methods of measuring cell percent of C, N and P, and calculating nutrients uptake rate by algal photosynthesis. The turnover time of phosphorus in phytoplankton metabolism ranged from 0.75-5.0 days during 1979-1986. The available P was 0.176 (plus or minus 0.156) g/cm m (mean plus or minus standard deviation) in The available P was 0.176 (plus or minus 0.156) g/cu m (mean plus or minus standard deviation) in 1982 and 0.591 (plus or minus 0.24) g/cu m in 1986. The relationship between P and biomass or P/B ratio (Y) and Total-p (X:mg/l) was described by the following regression equation Y = 1.163 + 0.512logX (r = 0.731, P < 0.001). The dynamics of algal biomass and algal species succession were monitored as the indicators of environmental enrichment. The small-sized algae have replaced the blue-green algae as the dominant species during 1979-1986. The small-sized algae include Merismopedia glauca, Cryptomonas ovata, Cryptomonas erosa, and several species of Cyclotella. There has been drastic decrease in algal biomass and an obvious increase in the P/B ratio. A nutrient competi-tion hypothesis is proposed to explain the reason for the disappearance of blue-green algae bloom. The drastic change in algal size and the high P/B ratio (reaching a maximum mean daily ratio of 1.09 in 1986) may suggest a transition of algal species from K-selection to r-selection in Lake Donghu. (Author's abstract) W91-10897

EFFECTS OF COPPER AND TRIBUTYLTIN ON STRESS PROTEIN ABUNDANCE IN THE ROTIFER BRACHIONUS PLICATILIS.

University of South Florida, Tampa. Dept. of Biol-

ogy. B. J. Cochrane, R. B. Irby, and T. W. Snell. Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 98, No. 2/3, p 385-390, 1991. 6 fig,

Descriptors: \*Aquatic animals, \*Copper, \*Heavy metals, \*Organotin compounds, \*Proteins, \*Rotifers, \*Toxicity, \*Toxicology, \*Water pollution effects, Genetics, Immunochemistry, Kinetics.

Evidence has accumulated in many species that very specific changes in patterns of gene expres-sion occur in response to toxicant exposure. The question relevant to environmental toxicology is question relevant to environmental toxicology is whether changes in expression of such genes are suitable for assessing toxicity. One experimental approach is to examine a response that is characteristic of a wide variety of organisms in a species for which classic toxicological measures can be readily obtained. This approach was employed by examinobtained. This approach was employed by examing the expression of a particular stress protein of 58,000 Da (SPS8) in the marine rotifer Brachionus plicatilis. Exposure of Brachionus plicatilis to elevated temperature resulted in the synthesis of a number of proteins, including a prominent one of 58,000 Da (SPS8). This protein is immunologically cross-reactive with the 65,000 Da heat shock protein of the moth Helitothis viercess which is tein of the moth Heliothis virescens, which is a member of a highly conserved family of mitochondrial proteins. Exposure of rotifers to sublethal doses of CuSO4 leads to a 4 to 5-fold increase in abundance of SP58, with maximum increase occurring at a does that it constitutions to the control of abundance of SPS8, with maximum increase occurring at a dose that is approximately 5% of the LC50 for that compound. A similar response was seen with tributylin (TBT). Kinetics of induction were sigmoidal, with induction occurring in the range of 20-30 microgram/L. No response was observed when rotifers were exposed to aluminum chloride, mercury chloride, pentachlorophenol, sodium arsenite, sodium azide, sodium dodecyl sulfate, or zinc chloride. These results indicate that changes in stress protein abundance may prove useful as a biomarker of exposure to particular toxicants. (Agostine-PTT)

DECREASED NOREPINEPHRINE AND EPINEPHRINE CONTENTS IN CHROMAFFIN TISSUE OF RAINBOW TROUT (ONCORHYNCHUS MYKISS) EXPOSED TO DIETHYLDITHIOCARBAMATE AND AMYLXANTH-

Uppsala Univ. (Sweden). Dept. of Zoophysiology. G. E. Nilsson, and M. Block.

Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 98, No. 2/3, p 391-394, 1991. 2 fig, 1 tab, 19 ref.

Descriptors: \*Carbamate pesticides, \*Epinephrine, \*Fish physiology, \*Norepinephrine, \*Toxicity, \*Toxicology, \*Trout, \*Water pollution effects, Enzymes, Path of pollutants.

A study was conducted to determine if a diethyl-dithiocarbamate (DDC) or amylxanthate (AX) exposure decreases the amounts of norepinephrine (NE) and epinephrine (E, which is synthesized from NE) present in the head kidney (pronephros) of rainbow trout. The head kidney contain chromaffin tissue which synthesize and store NE and E and subsequently release these stress hormones into the blood. Rainbow trout (Oncorhynchus mykiss) were exposed to 0.5 or 5.0 micro M of DDC or AX for 24 hours. Both DDC (0.5-5.0 microM) and AX (5.0 microM) significantly decreased NE and E levels in the head kidney as well as the quotients epinephrine/dopamine and/or norepinephrine/dopamine the results of the synthesis of NE and E from dopamine. It results probably reflect an inhibition of dopamine-beta-hydroxylase, the enzyme responsible for the synthesis of NE and E from dopamine. study was conducted to determine if a diethylsible for the synthesis of NE and E from dopamine. It is concluded that an exposure of fish to these complexing agents could disturb physiological processes controlled by catecholamines. Diethyl-dithiocarbamate may prove to be a valuable pharmacological tool for the study of catecholamine function in fish. (Agostine-PTT)

### Effects Of Pollution—Group 5C

W91-10901

GROUNDWATER MANAGEMENT MODEL FOR SALT LAKE COUNTY, UTAH WITH SOME WATER RIGHTS AND WATER QUAL-ITY CONSIDERATIONS.

Utah State Univ., Logan. Dept. of Civil and Envi-ronmental Engineering. For primary bibliographic entry see Field 4B. W91-10911

## OZONE, ACIDIC PRECIPITATION, AND SOIL MG EFFECTS ON GROWTH AND NUTRITION OF LOBLOLLY PINE SEEDLINGS.

Tennessee Valley Authority, Norris. Cooperative

G. S. Edwards, N. T. Edwards, J. M. Kelly, and P. A. Mays. Environmental

and Experimental Environmental and Experimental Botany EEBODM, Vol. 31, No. 1, p 67-78, January 1991. 4 fig, 6 tab, 39 ref. Electric Power Research Insti-tute Contract RP-2799-2, U.S. Department of Energy Contract DE-AC05-84OR21400.

Descriptors: \*Acid rain, \*Air pollution effects, \*Magnesium, \*Ozone, \*Pine trees, \*Plant growth, \*Soil-water-plant relationships, Conifers, Leaching, Nutrients, Nutrition, Precipitation, Seedlings, Simulated rainfall, Soil chemistry, Soil types, Throughfall

The height, diameter, biomass, and nutrient con-centration and content were determined for lobloid ly pine (Pinus taeda L.) seedlings grown at two levels of soil Mg and exposed to chronic levels of czone and simulated acidic precipitation. Nutrient contents in precipitation and throughfall were also contents in precipitation and throughfall were also determined. Seedlings were planted in a sandy loam soil (Lilly series) having approximately 15 or 35 mg/kg Mg and were exposed to sub-ambient, ambient, or twice ambient concentrations of ozone in open top chambers from May to October of 1984. Seedlings also received simulated rainfall at pH 3.8 or 5.2 in volumes equivalent to ambient rainfall. After two growing seasons, height and diameter were significantly greater for seedlings exposed to unb-ambient. growing seasons, height and diameter were significantly greater for seedlings exposed to sub-ambient and twice ozone than for seedlings exposed to ambient ozone. Biomass of all seedling components was progressively reduced with increasing ozone concentrations. Net throughfall nutrient contents and foliar nutrient contents were not significantly affected by precipitation pH treatments, indicating that foliar leaching was not accelerated by increasing the acidity of precipitation from pH 5.2 to 3.8. Throughfall and foliar nutrient contents were not significantly affected by ozone treatments, and no significant ozone x precipitation pH interactions occurred, indicating that after two growing seasons ozone did not act to exacerbate foliar leaching. Seedlings grown in soil having 15 mg/kg Mg sons ozone did not act to exacerbate foliar leaching. Seedlings grown in soil having 15 mg/kg Mg exhibited significantly reduced Mg concentrations and contents in all components, but seedling growth was not significantly affected by this treatment. (Author's abstract) W91-10918

# EFFECTS OF DROUGHT STRESS AND SIMULATED ACIDIC RAIN ON FOLIAR CONDUCTANCE OF ZEA MAYS L.

ANCE OF ZEA MAYS L.
Pennsylvania State Univ., University Park. Dept.
of Plant Pathology.
R. Knittel, and E. J. Pell.
Environmental and Experimental Botany
EEBODM, Vol. 31, No. 1, p 79-90, January 1991.
4 fig. 5 tab, 36 ref. Pennsylvania Department of
Agriculture Contracts ME 4614 and ME 48008.

Descriptors: \*Acid rain effects, \*Corn, \*Drought effects, \*Moisture stress, \*Plant-water relation-ships, \*Stomatal transpiration, Acid rain, Conduct-ance, Greenhouses, Leaves, Plant growth, Simulated rainfall

Studies were conducted to determine if simulated Studies were conducted to determine it simulated acidic rain (SAR) could predispose Zea mays L. cv. B73 x Mo17 to drought stress by altering cuticular and stomatal conductance. Experiments were conducted with field-grown plants in 1986, 1987, and 1988, and with greenhouse-grown plants

in 1987 and 1988. Plants were treated with SAR of pH 5.0 or 3.0 twice weekly. In the field two droughts, approximately 2 weeks in duration, were imposed by withholding water; one followed silking and the other occurred during grain fill. In the greenhouse one 10-day drought was imposed following 3-4 weeks of SAR treatments, which began at emergence. During the drought stress, cuticular and stomatal conductances were measured. Drought significantly decreased cuticular conductance in the field on 3 days in 1986. 2 days in 1987, and 3 days in 1988. Rain pH had no effect on cuticular conductance, and there was a significant drought-by-pH interaction on day 1 in 1987 in cuticular conductance, and there was a significant drought-by-pH interaction on day 1 in 1987 in which plants treated with rain of pH 3.0 under non-drought conditions had the highest cuticular conductance. Stomatal conductance was significantly decreased by drought on 5 days in 1986, 8 days in 1987 and on 1 day in 1988. Rain pH 3.0 increased stomatal conductance on 2 days in 1987 increased stomatal conductance on 2 days in 1987 and decreased stomatal conductance on 1 day in 1988. There were no significant interactions. Greenhouse results showed decreased cuticular conductance as drought progressed with no interactive effects due to SAR. In 1988, plants treated with SAR of pH 5.0 had a higher cuticular conductance than plants treated with pH 3.0 for 2 days of the drought. Drought was a more significant physiological stress for cv. B73 x Mo17 of Z. mays than was SAR. (Author's abstract)

### LC-50 ESTIMATES AND THEIR CONFIDENCE INTERVALS DERIVED FOR TESTS WITH ONLY ONE CONCENTRATION WITH PAR-TIAL EFFECT.

Institute of Environmental Sciences TNO. Delft

N. van der Hoeven

Water Research WATRAG, Vol. 25, No. 4, p 401-408, April 1991. 3 fig, 2 tab, 3 ref, 2 append.

Descriptors: \*Confidence intervals, \*Lethal limit, \*Median tolerance limit, \*Statistical methods, \*Toxicology, \*Water pollution effects, Ecotoxicology, Lethal concentrations, Mathematical studies, Maximum likelihood estimators, Mortality, Statisti-

When several test concentrations lead to a partial mortality with a concentration-effect relationship the maximum likelihood estimators (MLE) of the various parameters and their confidence intervals various parameters and their confidence intervais can be calculated using a linear approximation. However, in many ecotoxicological experiments partial mortality is only observed at one test concentration, even though the ratio between the test concentrations is fairly small. In that case the calculation of the MLEs of the parameters, and even more of their confidence intervals is not straight-forward. The likelihood isoclines appear to have a rather unusual form, with the MLE on the border rather unusual form, with the MLE on the border of each confidence set with likelihood greater than some arbitrary value. The likelihood-ratio basic confidence intervals are calculated. It is concluded that linear approximation fails to determine the likelihood based confidence interval for the LC-50 parameter (the concentration at which half of the test animals are killed by the test substance) in a toxicity experiment with only one concentration causing mortality. An equation for this confidence causing mortality. An equation for this confidence interval is derived given a log-logistic concentration response relation. A table of the 95 and 99% confidence intervals is given for the case that partial survival occurs only at one concentration, under the condition that a fixed number of animals is used at each test concentration and a constant ratio is used between the test concentrations.
(Agostine-PTT)
W91-10930

# HUMIC SUBSTANCES IN ACID SURFACE WATERS; MODELLING ALUMINIUM BIND-ING, CONTRIBUTION TO IONIC CHARGE-BALANCE, AND CONTROL OF PH.

BALANCE, AND CONTROL OF FI.
Freshwater Biological Association, Ambleside
(England). Windermere Lab.
E. Tipping, C. Woof, and M. A. Hurley.
Water Research WATRAG, Vol. 25, No. 4, p 425435, April 1991. 5 fig, 6 tab, 37 ref.

Descriptors: \*Acid rain, \*Acidic water, \*Aluminum, \*Humic substances, \*Model studies, \*Water pollution effects, Anions, Cations, Dissolved solids, Hydrogen ion concentration, Optimization, Statis-

A discrete-site model of ion-binding by humic sub-A discrete-site model of ion-binding by humic sub-stances (HS), incorporating a description of elec-trostatic effects, is evaluated with analytical data for surface waters of acid pH (3.5-6.5). After opti-mization of the model by adjustment of the bind-ing-site content of the HS, the root-mean-square deviation (RMSD) between measured and calculat-ed concentrations of organically-complexed mono-meric aluminum is 1 microM for a range of mea-sured values of 0.1-9.0 microM (108 samples from 12 different locations). The optimization indicates 12 different locations). The optimization indicates that the dissolved organic matter of natural waters is only about 50% as 'active' (in the sense of ion-binding) as isolated HS. The model, optimized for Al-binding, also accounts for the contributions of HS to ionic balance; for 139 samples (from 8 Its to folio balance; for 139 samples (from 6 locations) with dissolved organic carbon concentrations in the range 4.6-43.0 mg/L, and using measured pH as input for the computations, the mean calculated ration of cations to anions was 1.03, with a standard deviation of 0.11. For the 1.03, with a standard deviation of 0.11. For the same 139 samples, pH values were also calculated, using total measured anion concentration as inputs. The RMSD in pH was 0.35 for all samples, but only 0.18 for the 56 samples of pH < or = 4.5. Statistical analyses indicate that inadequacies in model assumptions, including the estimation of concentrations of HS in water samples, account for about one-third of the discrepancy between measured and calculated organically-complexed monomeric aluminum; the remaining two-thirds is explained by errors in input data and measured organically-complexed monomeric aluminum. In the case of pH prediction, no model inadequacy is case of pH prediction, no model inadequacy is apparent, because of the high sensitivity of the calculations to errors in input data. (Author's ab-W91-10933

# FACTORS AFFECTING THE RELATIONSHIP BETWEEN THE NBOD VALUES AND THE AMOUNTS OF NITROGENOUS POLLUT-ANTS: A FIELD STUDY ON THE LEE RIVER.

Beijing Univ. (China). Dept. of Geography. J. Deai, T. Yida, Y. Gong, Z. Jianrong, and S

Water Research WATRAG, Vol. 25, No. 4, p 485-489, April 1991. 1 fig, 4 tab, 12 ref. National Science Foundation Project (86) GKJD 005.

Descriptors: \*Biological oxygen demand, \*Nitro-gen compounds, \*Nutrient transport, \*Path of pol-lutants, \*Stream pollution, \*Water pollution ef-fects, China, Field tests, Hydrogen ion concentra-tion, Hydrologic aspects, Statistical analysis, Water

The relationships between the nitrogenous biological oxygen demand (NBOD) values, the amounts of nitrogenous pollutants and the effects of some environmental factors on these relationships were investigated. The relationship between the NBOD and the oxidizable nitrogenous pollutants in the Lee River, near Tianjin, China, has been determined to be dependent upon the hydrological control of the mined to be dependent upon the hydrological con-ditions. When there is no water discharge (NWD) from the upper reservoir, this relationship is quite clear and definite, but under water discharge (WD) conditions, this relationship is not well defined. Mean ratios of NBOD's to BOD's are 0.620 for the NWD case and 0.379 for the WD case, with maximum ratios of 0.944 and 0.643, respectively. Differences between these two cases are caused mainly by the variations of several factors such as concentration of oxidizable nitrogen compounds, an abun-dance of nitrifying organisms, pH and velocity and depth of water. The hydrological conditions play an important role in these variations. (Agostine-PTT W91-10940

SOME UPDATED STATISTICAL ASSESSMENTS OF THE SURFACE TEMPERATURE

### Group 5C-Effects Of Pollution

RESPONSE TO INCREASED GREENHOUSE

Frankfurt Univ. (Germany, F.R.). Inst. fuer Meteorologie und Geophysik.
For primary bibliographic entry see Field 2B.
W91-10969

CLIMATIC CHANGE AND FUTURE AGRO-CLIMATIC POTENTIAL IN EUROPE. Birmingham Univ. (England). Dept. of Geogra-

For primary bibliographic entry see Field 2B. W91-10970

ACUTE PHOTOTOXICITY OF HARBOR AND TRIBUTARY SEDIMENTS FROM LOWER LAKE MICHIGAN.
Illinois Univ. at Urbana-Champaign. School of

Journal of Great Lakes Research JGLRDE, Vol. 17, No. 1, p 51-56, 1991. 6 fig, 15 ref.

Descriptors: \*Lake Michigan, \*Lake sediments, \*Light effects, \*Photoactivation, \*Toxicity, \*Toxicology, \*Water pollution effects, Dredging, Great Lakes, Photolysis, Polycyclic aromatic hydrocarbons, Shallow water, Waterfleas.

A number of recent findings suggest that the inter-action between sediment pollutants and sunlight might pose a hazard which has been previously might pose a hazard which has been previously unsuspected; the phototoxicity of polycyclic aromatic hydrocarbons (PAHs), together with their accumulation in sediments, suggest that dredging and other disturbances may pose a presently unrecognized environmental hazard. To test this, sediments contaminated with PAHs were collected from sites on lower Lake Michigan (the Grand Calumet River, the Indiana Harbor Canal, and Waukegan Harbor). The phototoxicity of liquid-phase elutriates was tested using Daphnia magna-phototoxicity was found in Grand Calumet River and Indiana harbor elutriates, both in sunlight and 354 nm near-uv. None of the elutriates was toxic in the absence of light. These results reveal an importhe absence of light. These results reveal an important and previously unsuspected hazard to sha water environments near dredging sites, and de-scribe simple methods to detect phototoxicity which will be of value in the establishment of sediment quality criteria. (Author's abstract) W91-10977

WATER SUPPLY IMPLICATION OF CLI-MATE CHANGE IN WESTERN NORTH AMERICAN BASINS.

Agricultural Research Service, Beltsville, MD. Hydrology Lab.

For primary bibliographic entry see Field 2B. W91-11059

SIMULATED HYDROLOGIC EFFECTS OF CLIMATIC CHANGE IN THE DELAWARE RIVER BASIN.

Geological Survey, West Trenton, NJ. M. A. Ayers, D. M. Wolock, G. J. McCabe, and

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 587-594, 5

Descriptors: \*Climatic changes, \*Delaware River Basin, \*Global warming, \*Hydrologic budget, Basin, "Global warming, "Hydrologic budget, \*Simulation analysis, Evapotranspiration, Model studies, Runoff, Snow, Streamflow, Water supply.

Projections of climatic change indicate uncertainty regarding future availability of water in the Dela-ware River basin. Simulations of the effects of atmospheric warming on runoff indicate that a decrease in snow accumulation in the northern part of the basin, and an increase in evapotranspiration or the basin, and an increase in evapotranspiration throughout the basin, could change the temporal distribution of runoff and reduce total annual streamflow by as much as 25% given current precipitation patterns. An increase in precipitation of about 3% would be needed to counteract decreases in runoff that would result from each degree Celsi-

us warming. Simulations indicate that without more reliable estimates of regional precipitation and warming patterns, the future direction and magnitude of basin streamflow changes cannot be determined precisely. (See also W91-11003) (Author's abstract)

GREAT LAKES HYDROLOGICAL IMPACTS OF 2XCO2 CLIMATE CHANGE. National Oceanic and Atmospheric Administra-tion, Ann Arbor, MI. Great Lakes Environmental Research Lab. T. E. Croley.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 595-604, 3 fig,

Descriptors: \*Great Lakes, Basin, \*Hydrologic budget, \*Carbon dioxide, \*Climate change, \*Precipitation, \*Global warming, Model studies, Atmospheric circulation, Air temperature, Evapotranspiration, Snowpack, Runoff, Ice, Soil water.

The Great Lakes Environmental Research Labora-In cyfeat Lakes Environmental Research Labora-tory considered climate change impacts on North American Great Lakes hydrology by using recent atmospheric general circulation model (GCM) sim-ulations of a doubling of atmospheric CO2, avail-able from the Goddard Institute for Space Studies. Changes were made in historical meteorological changes were made in insortical interotological data, similar to the changes observed in the GCM, and the impact of the changed data in hydrology models for basin moisture storage and runoff, overlake precipitation, and lake heat storage and evaporation were observed. While precipitation changes are uncertain, higher air temperatures generally increase basin evapotranspiration which decreases the snowpack, lowers runoff, shifts runoff peaks, and reduces soil moisture. There are larger amounts of heat resident in the deep lakes reducing buoyancy-drive turnovers of the water column, lowering ice formation, and increasing lake evaporation. (See also W91-11003) (Author's abstract) W91-11061

ENVIRONMENTAL PROBLEMS AND SOLU-TIONS: GREENHOUSE EFFECT, ACID RAIN, POLLUTION.

For primary bibliographic entry see Field 5B. W91-11066

OBSERVATIONAL AND THEORETICAL STUDIES OF GREENHOUSE CLIMATE EF-

Lawrence Livermore National Lab., CA. Atmospheric and Geophysical Sciences Div. K. E. Taylor, and S. L. Grotch.

In: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemisphere Publishing Corporation, New York. 1990. p 3-16. 10 fig. 25 ref. US DOE Contract No. W-7405-Eng-48.

Descriptors: \*Air pollution effects, \*Air tempera-ture, \*Carbon dioxide, \*Climatic changes, \*Clima-tology, \*Global warming, \*Greenhouse effect, Chlorocarbons, Climates, Estimating, Fuel, Mathe-matical models, Methane, Model studies, Prediction, Trace gases.

The carbon dioxide concentration in the atmosphere has increased by about 25% over the last 150 years and will continue to increase as a result of years and will continue to increase as a resuit of fossil fuel combustion. Enhancement of the atmospheric greenhouse effect by elevated levels of carbon dioxide and other trace gases may, over the next century, increase global average surface air temperature by a few degrees Celsius to levels unprecedented in human history. Even eliminating emissions of carbon dioxide will not prevent global climate change because the combined greenhouse effect of less abundant but radiatively important gases such as methane and chlorocarbons is likely gases such as inclinate and chilorocarbons is likely to be as large as the impact of projected increases in carbon dioxide concentration. Quantitative esti-mates of future warming that could result of continued increases in greenhouse gas concentrations come from sophisticated mathematical models,

which are the modern climatologists' primary prognostic tool. The current limitations and uncer-tainties in these model results, however, prevent definitive predictions of the regional climatic re-sponses that make up the projected global change. Deficiencies in the historical climate record prevent confirmation of the climate model predictions, but future research offers the potential for im-proved understanding. (See also W91-11066) (Au-thor's abstract) W91-11067

CHALLENGE OF SUSTAINING PRODUCTIVITY IN THE FACE OF CO2-INDUCED CHANGE.

Environmental Protection Agency, Washington, DC. Office of Policy Analysis.

J. S. Hoffman.

IN: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemisphere Publishing Corporation, New York. 1990. p 101-108. 5 ref.

Descriptors: \*Air pollution effects, \*Carbon dioxide, \*Climatic changes, \*Climatology, \*Crop production, \*Global warming, \*Research priorities, Climates, Economic aspects, Future planning, Greenhouse effect, Path of pollutants, Sea level.

Rising levels of atmospheric carbon dioxide could change the climatic characteristics of the world's change the climatic characteristics of the world's regions, alter biological relationships, and raise sea level. Anticipating the fast evolution of the earth's natural systems caused by rising carbon dioxide would allow economic adjustment to conditions that emerge in a manner that enhances productivithat energe in admire that elimances productivi-ty. Current research efforts, however, are not pro-viding information at an adequate rate. In particu-lar, almost no efforts are being made to establish the value of better information. As a result, the the value of better information. As a result, the importance of accelerating basic and applied science research, and of taking other responses cannot be assessed. Given the strength of scientific beliefs about the likely magnitude of carbon dioxide-induced changes, continued failure to consider the economic consequences of carbon dioxide would not be prudent. (See also W91-11066) (Authoric between the contract of the contract thor's abstract)

EFFECTS OF ACID RAIN ON EPIPHYTIC ORCHID GROWTH.

Barry Univ., Miami Shores, FL. Div. of Biological and Biomedical Sciences.

J. K. Frei, C. Orenic, N. Smith, and H. Jeffer IN: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemisphere Publishing Corporation, New York. 1990. p 149-163. 3 tab, 24 ref.

Descriptors: "Acid rain, "Acid rain effects, "Epi-phytes, "Orchids, "Plant growth, "Water pollution effects, Big Cypress Swamp, Florida, Hydrogen ion concentration, Path of pollutants, Plant-water relationships, Simulated rainfall.

The Big Cypress Swamp in South Florida has a high diversity level of subtropical flora and fauna. Among the species of subtropical vegetation occurring in this area are many epiphytic plants which are vulnerable to atmospheric inputs. Some preliminary evidence indicates that this general area may be experiencing elevated concentrations of gaseous and particulate air pollutants, but very little is known about the potential impact on biological resources. The effects of simulated acid rain logical resources. The effects of simulated acid rain were tested at several pH levels to evaluate impact on growth and development of the epiphytic orchid plant Encyclia tampensis. The sixty plants used were collected from the Fakhahatchee Strand located within the Big Cypress Swamp. Plants used were mature plants, intermediate sized plants and young seedlings, which were exposed to the pH ranges of simulated acid rain (pH 2.5, 4.0, 5.6) for a period of six months. Observations were made on the number and conditions of flower spikes and flower buds; number and conditions of nower spikes and flower buds; number and condition of new and old leaves; and the general condition of the plant. The results indicated a negative effect on the growth rate of plants exposed to varying levels

### Effects Of Pollution—Group 5C

of simulated acid rain mistings. (See also W91-11066) (Author's abstract) W91-11076

RELATIONSHIP OF REGIONAL WATER QUALITY TO AQUIFER THERMAL ENERGY STORAGE. Battelle Northwest Labs., Richland, WA.

Battele Facilit Vorthwest Loss, Richiand, WA. R. D. Allen, and J. R. Raymond. IN: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemi-sphere Publishing Corporation, New York. 1990. p 415-435. 1 fig, 3 tab, 26 ref.

Descriptors: \*Aquifer management, \*Groundwater quality, \*Heat storage, \*Model studies, \*Permeability, \*Thermal energy, \*Water pollution sources, Corrosion, Evapotranspiration, Hydrogen ion concentration, Ion exchange, Mineral oxidation, Precipitation, Rock properties, Salinity, Water resources development.

Aquifer thermal energy storage (ATES) involves injection and withdrawal of temperature-conditioned water into and from a permeable water-bearing formation. The groundwater quality and associated geological characteristics were assessed as they may affect the feasibility of ATES system as they may affect the feasibility of ATES system development in any hydrologic region. Seven physical and chemical mechanisms may decrease system efficiency: particulate plugging, chemical precipitation, clay mineral dispersion, piping corrosion, aquifer disaggregation, mineral oxidation, and the proliferation of biota. Factors affecting groundwater quality are pressure, temperature, pH, ion exchange, evaporation/transpiration, and commingling with diverse waters. Modeling with the MINTEQ code showed three potential reactions: precipitation of calcium carbonate at raised tions: precipitation of calcium carbonate at raised temperatures; solution of silica at raised temperature followed by precipitation at reduced tempera-tures; and oxidation/precipitation of iron compounds. Low concentrations of solutes are generally favorable for ATES. Near-surface waters in high precipitation regions are low in salinity. Groundwater recharged from fresh surface waters also has reduced salinity. Rocks least likely to react aiso has reduced sainnty. Rocks least likely to react with groundwater are sliceous sandstones, regoliths, and metamorphic rocks. Limestone, dolomite, shale and basalt contain reactive minerals. Intrusive rocks may yield alkalis, alkaline earths, and iron by hydrolysis of feldspathic and ferromagnesian minerals. On the basis of known aquifer hydrology, ten US water resource regions are can-didates for selected exploration and development, all characterized by extensive silica-rich aquifers. (See also W91-11066) (Author's abstract) W91-11082

PRELIMINARY DATA SUMMARY FOR IN-DUSTRIAL LAUNDRIES. For primary bibliographic entry see Field 5B. W91-11093

KINETICS OF CHEMICAL WEATHERING IN B HORIZON SPODOSOL FRACTION, Iowa Univ., Iowa City. Dept. of Civil and Envi-ronmental Engineering. S. R. Asolekar, R. L. Valentine, and S. L.

Schnoor.

Water Resources Research WRERAQ, Vol. 27, No. 4, p 527-532, April 1991. 5 fig. 1 tab, 26 ref. USEPA Watershed Manipulation Cation Resupply Grant CR-813634-01.

Descriptors: \*Acid rain, \*Acid rain effects, \*Kinetics, \*Maine, \*Soil horizons, \*Weathering, Geochemistry, Hydrogen ion concentration, Soil chemistry, Soil properties, Solute transport.

Knowledge of the kinetics of chemical weathering Knowledge of the kinetics of chemical weathering is central to understanding the global hydrogeochemical cycle whereby weatherable minerals in rocks transform to soils, sediments, and ultimately to sedimentary rocks. Studies on a B horizon soil from Maine were conducted to determine the dependence of the weathering rate on hydrogen ion concentration in soil solution. Effects of soil concentration and solution chemistry on chemical weathering rate also were investigated. Studies

were conducted using a laboratory stat pH-stat semicontinuous reactor at pH 2.7 and pH 3.5 for two concentrations of B horizon soil. Homog-enized B horizon soil in the size range 63-125 micrometer was washed in deionized water and acetone and used without further treatment. Results obtained with titrations of 10, 30, and 100 g/L solution obtained with utrations of 10, 30, and 100 g/L of soil at a constant pH of 2.7 suggest that the weathering rate, expressed as microequivalents of H(+)/hr/g soil, does not depend on the soil concentration in the pH-stat reactor. To test the effect of solute concentration on weathering rate, experi-ments were performed at two different concentrations of accumulated solutes. Weathering rates were the same at the two solute concentrations, indicating that significant back reactions likely were not occurring. The weathering rate at pH 2.7 was estimated to be in the range 0.53-0.93 microequivalents H(+)/hr/g soil, at pH 3.5 at 0.36 microequivalents H(+)/hr/g soil, at pH 3.5 at 0.36 microequivalents H(+)/hr/g soil, and at pH 4.0 at 0.04 microequivalents H(+)/hr/g soil. Assuming a weathering rate proportional to (H(+)) to the m power, the fractional order m was determined to be approximately 0.8. Results were consistent with a surface reaction-controlled dissolution mechanism. (Author's abstract)

URBANIZATION AND URBAN WATER PROB-LEMS IN SOUTHEAST ASIA: A CASE OF UN-SUSTAINABLE DEVELOPMENT. Malaya Univ., Kuala Lumpur (Malaysia). Inst. for Advanced Studies.

For primary bibliographic entry see Field 6G. W91-11263

MARINE MONITORING IN HETEROGENE-OUS ENVIRONMENTS.

EcoAnalysis, Inc., Ojai, CA. For primary bibliographic entry see Field 5A. W91-11264

STANDARD TEST FISH FOR INDIA AND THE NEIGHBORING COUNTRIES, Nagarjuna Univ., Nagarjunanagar (India). Dept. of Zoology.

For primary bibliographic entry see Field 5A. W91-11300

ENHANCEMENT OF HEPATOCARCINOGEN-ESIS IN RAINBOW TROUT WITH CARBON TETRACHLORIDE.

Trent Univ., Peterborough (Ontario). Environmental and Resource Studies Program.

N. Kotsanis, and C. D. Metcalfe.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 46, No. 6, p 879-886, June 1991. 1 fig, 1 tab, 15 ref.

Descriptors: \*Carcinogens, \*Chlorinated hydrocarbons, \*Fish pathology, \*Liver, \*Synergistic effects, \*Toxicity, \*Toxicology, \*Trout, \*Water polution effects, Animal pathology, Animal tissues, Bioassay, Chronic effects, Morbidity, Tissue analy-

Rainbow trout (Oncorhynchus mykiss, formerly Salmo gairdneri) are sensitive to a number of chemical hepatocarcinogens. This study was conducted to determine whether, in the rainbow trout carcinogenesis model, proliferation of liver cells in response to post-initiation treatment with carbon carcinogenesis model, prolineration of liver cells in response to post-initiation treatment with carbon tetrachloride (CCI4) enhances liver tumor development. Rainbow trout were microinjected at the sac fry stage of development with dimethyl sulfoxide (DMSO; control) or 20 ng aflatoxin B1 (AFBI) in DMSO. Following microinjection, half of the fish were not treated further and the remainder were repeatedly exposed to 1 mL/kg doses of CCl4 by intraperitoneal (i.p.) injection. Examination of sections of liver tissue from trout sacrificed 2 weeks after injection with CCl4 revealed that there ancer injection with CCI4 revealed that there was focal necrosis of hepatocytes and numbers of mitotic figures were elevated throughout the liver. No pathological lesions were seen on any of the internal organs except the liver. Hepatocellular carcinomas were observed at both the 3 and 6 month necropsies in treatments with AFB1 initi-

ation. No grossly-visible liver lesions were observed in the DMSO and DMSO+CCl4 groups at 3 or 6 months. Only single tumors were generally observed grossly in the AFBI group, whereas in the AFBI+CCl4 group, both single and multiple (2 to 4) tumors were observed grossly in the livers. (2 to 4) tumors were observed grossly in the invers. There was no significant difference between AFB1 and AFB1+CCl4 treatments in the total incidence of basophilic lesions (preneoplastic plus neoplastic) observed in the histologic survey. Multiple treatments with CCl4 enhanced AFB1-initiated hepatoments with CCl4 enhanced AFBI-initiated hepato-carcinogenesis in trout over a short latency period (3 months). However, an obvious enhancing effect by multiple treatments with CCl4 over a longer latency period (6 months) was not seen. Exposure of wild fish to weak carcinogens in association with hepatotoxic chemicals or pathogens may lead to liver tumor development. (VerNooy-PTT) W91-11301

TOXICITY OF METALS TO A FRESHWATER TUBIFICID WORM, TUBIFEX TUBIFEX

Industrial Toxicology Research Centre, Lucknow (India). Preventive Toxicology Div.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 46, No. 6, p 906-912, June 1991. 2 tab, 18 ref.

Descriptors: \*Bioindicators, \*Heavy metals, \*Metals, \*Toxicity, \*Toxicology, \*Tubificids, \*Water pollution effects, Aquatic animals, Bioassay, India, Sublethal effects.

The freshwater tubificid worm, Tubifex tubifex (Muller) forms an important link in aquatic food chains and are useful indicators of varying degrees of aquatic pollution. Tubificid worms were collected from the Gheru Campus of ITRC, Lucknow, India, and exposed to concentrations of 33 metal ions in replicates of three. The 24, 48, and 96-hour ions in replicates of three. The 24, 48, and 96-hour EC50s (effective concentration at which 50% immobilization response was recorded) and 95% confidence limits were determined. The metal ions tested included Os, Ag, Pb, Hg, Pt, Pd, Cr, Bi, U, Se, Li, As, Be, Zn, Sn, Mo, La, Ba, Cd, Ni, Al, Fe, Co, Te, Mg, Mn, Zr, Sr, Ca, Sb, Na, and K. Results suggest that osmium (0s) and silver (Ag) were the most toxic (48-hour EC50s were 0.009 and 0.039 mg/L), and sodium (Na) and potassium (K) the least toxic ions (48-hour EC50s were 1016 and 1320 mg/L). Results also suggest that mercury (Hg), copper (Cu) and cadmium (Cd) are more and 1520 mg/L). Results also suggest that increasing (Hg), copper (Cu) and cadmium (Cd) are more toxic than chromium (Cr), zinc (Zn), and nickel (Ni). It is suggested that there is a common, non-specific, toxic action for most metal cations, which specific, toxic action for most metal cations, which can be related to their strength of covalent binding to the ionogenic group, for example, with imidazole, carboxyl and sulphydryl groups. However, for non-transitional metal cations, enzyme inhibition is not likely to be a primary factor in toxicity. But osmotic or other colligative factors operating though physical reactions cause physical damage to the cellular system. (VerNooy-PTT) W91-11303

ASSESSMENT OF MERCURY TOXICITY BY THE CHANGES IN OXYGEN CONSUMPTION AND ION LEVELS IN THE FRESHWATER SNAIL, PILA GLOBOSA, AND THE MUSSEL, LAMELLIDENS MARGINALIS.

Sri Krishnadevaraya Univ., Anantapur (India). Dept. of Zoology.

B. Sivaramakrishna, K. Radhakrishnaiah, and A.

Bulletin of Environmental Contamination and Toxicology BECTA6, Vol. 46, No. 6, p 913-920, June 1991. 5 fig, 16 ref.

Descriptors: \*Heavy metals, \*Mercury, \*Mussels, \*Snails, \*Toxicity, \*Toxicology, \*Water pollution effects, Animal metabolism, Animal tissues, Bioassay, Bivalves, Gastropods, Median tolerance limit, Mortality, Sublethal effects, Tissue analysis.

The concentration of mercury (Hg) in aquatic ecosystems has been significantly increasing with the discharge of the effluents from various industries. The level of tolerance of the freshwater gastropod

### Group 5C-Effects Of Pollution

Pila globosa (Swainson) and of freshwater bivalve Lamellidens marginalis (Lamarck) to mercury at lethal and sublethal levels was determined and compared with the rate of whole animal oxygen consumption and the level of sodium, potassium consumption and the level of sodium, potassium and calcium ions in the hepatopancreas and the foot of these animals. The 120 hour LC50s for snails obtained from percent and probit mortality curves and Dregstedt and Behren's method are 4.467, 4.467 and 4.477 mg/L, respectively, and for mussels 3.311, 3.020 and 2.754 mg/L. The high tolerance capacity of snails and mussels to mercury could be due to their sedentary nature and/or adaptive ability, or because these animals may close up and not react to their environment. The rate of oxygen consumption of snails and mussels decreased at the respective exposure periods studdecreased at the respective exposure periods studdecreased at the respective exposure periods stud-ied in both lethal and sublethal concentrations of mercury. Data revealed a decrease in sodium, potassium and calcium levels in hepatopancreas and an increase in sodium levels in the foot of snails and mussels exposed to mercury. In lethal concentrations there was a gradual net loss of these ions from 1 to 5 days. In sublethal concentrations, the slow regain of the sodium, potassium and calcium ions and the gradual recovery in the rate of oxygen consumption to normalcy indicate the attainment of homeostasis on prolonged exposure of these animals to chronic toxic stress. These compensatory adjustments were more or less similar in both animal groups (VerNooy-PTT)

W91-11304

FERTILITY OF WORKERS CHRONICALLY EXPOSED TO CHEMICALLY CONTAMINATED SEWER WASTES,

Cincinnati Univ., OH. Coll. of Medicine.
For primary bibliographic entry see Field 5D.
W91-11316

EFFECT OF COAL-MINE EFFLUENT ON FUNGAL ASSEMBLAGES AND LEAF BREAK-

DOWN. Sheffield Univ. (England). Dept. of Animal and

Plant Sciences. L. Maltby, and R. Booth. Water Research WATRAG, Vol. 25, No. 3, p 247-250, March 1991. 1 fig, 3 tab, 36 ref.

Descriptors: \*Environmental impact, \*Fungi, \*Litter, \*Mine wastes, \*Water pollution effects, Coal mine wastes, Coal mining effects, Decomposition, Leaves, Water pollution sources.

Although fungi play an important role in the func-Atthough using just an important role in the func-tioning of many freshwater systems, information on their response to pollutants is scarce. The aim of this study was to investigate the effect of coal-mine effluent on the structure and functioning of fungal assemblages. Fungi present above and below the effluent outfall of a disused coal mine below the effluent outfail of a disused coal mine were surveyed. In the upstream site there were more species (23 compared to 20) and, possibly more importantly, twice as many aquatic Deuteromycotina. It is this group of fungi, which includes the aquatic Hyphomycetes, that has been implicated in leaf litter breakdown, and litter-bag experiments confirmed that decomposition rates were reduced below the effluent outfall. In addition reduced below the effluent outfall. In addition, leaves incubated at the downstream site had higher C:N ratios. Results from this study suggest that the mine effluent was having an effect on: the fungi present, the rate of leaf breakdown, and the biochemical composition of decomposing leaves. The chemical composition of decomposing leaves. The implications of these effects for invertebrate shredders are considerable. (Author's abstract) W91-11320

GAMMARUS: ASELLUS RATIO AS AN INDEX OF ORGANIC POLLUTION. Brighton Polytechnic (England). Dept. of Civil

Engineering. For primary bibliographic entry see Field 5A. W91-11331

SIMPLIFIED PHOSPHORUS TROPHIC STATE MODEL FOR WARM-WATER TROPI-CAL LAKES.

Pan American Center for Sanitary Engineering

and Environmental Sciences, Lima (Peru). H. J. Salas, and P. Martino. Water Research WATRAG, Vol. 25, No. 3, p 341-350, March 1991. 7 fig, 8 tab, 39 ref.

Descriptors: \*Eutrophication, \*Model studies, \*Phosphates, \*Reservoirs, \*Water pollution effects, International commissions, Lake classification, Latin America, Multipurpose reservoirs, Phosphorous, Planning, Regional planning, Tropical regions, Water manager

The explosive demographic growth in Latin America and the Caribbean over the past years, with the increased demand for water resources, has accelerated the construction of multipurpose reservoirs for potable and industrial water supplies, irrigation water and hydroelectric power. Many of these reservoirs and also natural lakes have suffered the effects of eutrophication which has inter-fered with the designated uses of these water bodies, and as such, the very purposes for which the reservoirs were created. The Pan American Center for Sanitary Engineering and Environmen-tal Sciences (CEPIS), a specialized Center of the Pan American Health Organization/World Health Organization (PAHO/WHO), has conducted a Re-gional Program since 1981 for the development of simplified methodologies for the evaluation of eu-trophication in warm-water tropical lakes/reservoirs of Latin America and the Caribbean. The majority of the regional lakes/reservoirs appear to majority of the regional lakes/reservoirs appear to be phosphorus limited. A warm-water tropical lake trophic state classification system and a simplified total phosphorus model have been developed with regional data, and successfully verified against the data of other lakes/reservoirs of the African continent. The use of the phosphorus model as a predictive tool in the management and planning of water resources is of more than scientific interest, since the desired water uses are closely dependent on the desired water uses are closely dependent on trophic state and consequent water quality. Given a total phosphorus concentration and using the model, the percent probability of the trophic state of a warm water tropical lake/reservoir can be determined. (Doyle-PTT) W91-11332

IN-SITU SEDIMENT OXYGEN DEMAND IN FIVE SOUTHWESTERN U.S. LAKES. Oklahoma State Univ., Stillwater. School of Civil

Engineering.
For primary bibliographic entry see Field 2H.
W91-11333

RESULTS OF THE FIRST PILOT-SCALE CONTROLLED COHORT EPIDEMIOLOGICAL IN-VESTIGATION INTO THE POSSIBLE HEALTH EFFECTS OF BATHING IN SEA-WATER AT LANGLAND BAY, SWANSEA. F. Jones, D. Kay, R. Stanwell-Smith, and M. Wyer.

Wyer. Journal of the Institution of Water and Environ-mental Management JIWMEZ, Vol. 5, No. 1, p 91-98, February 1991. 8 tab, 45 ref.

Descriptors: \*England, \*Epidemiology, \*Public health, \*Swimming, \*Water pollution effects, \*Water quality standards, Beach contamination, Comparison studies.

A pilot study was conducted to investigate the feasibility of using adult volunteers to examine the possible health effects of bathing in England's seawaters which passed the European Community (EC) bathing waters Directive. Adult volunteers were recruited from the City of Swansea and ranwere recruited from the City of swanses and ran-domly divided into bather and non-bather groups. All volunteers were given medical examinations and medical questionnaire interviews before and after the bathers were required to swim in the sea and immerse their heads underwater at least three times during bathing. Non-bathers were required to visit the designated beach area on the same day as the bathers but were not permitted to enter the water. Water quality on the day of bathing was relatively unpolluted as indexed by bacterial and viral indicator species. The detailed medical ques-tionnaire resulted in higher reported attack rates of perceived illness in both bather and non-bather groups than those published in previous studies,

which have commonly employed a single tele-phone interview to acquire disease perception data. Statistically-significant differences in the batter and non-bather cohorts were found for the followand non-bather cohorts were found for the following perceived symptoms: sore throat, ear symptoms, eye symptoms at 3 days after swimming, and
diarrhea at three weeks after swimming. The clinical tests employed failed to confirm these significant perceived symptom attack rate differentials.
This novel prospective controlled cohort approach, if taken to a full-scale study, could offer
considerable advantages over nast methods of colconsiderable advantages over past methods of col-lecting health effect data of recreational water use, such as retrospective studies, prospective percep-tion studies, or cross-sectional investigations. (Geiger-PTT) W91-11366

DOWNSTREAM CHANGES IN CADDISFLY COMPOSITION AND ABUNDANCE IN RELA-TION TO CHANGES IN WATER CONDUCTIV-ITY AND OXYGEN IN THE RIVER BUTRON ASTN.

Universidad del Pais Vasco, Bilbao (Spain). Lab. de Ecologia.

A. Basaguren, and E. Orive. Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 75, No. 3, p 303-316, 1990. 4 fig, 3 tab, 30 ref.

Descriptors: \*Bioindicators, \*Butron River Basin, \*Caddisflies, \*Distribution patterns, \*Species diversity, \*Water pollution effects, Dissolved oxygen, Flow discharge, Land use, Mineralization, Physicochemical properties, Population dynamics, Spain Species composition. Spain, Species composition.

The Butron River in the Basque Country (northern Spain) is a low gradient watercourse with a bottom of gravel and sand for most of its length surrounded by clear-cut areas of conifer plantations. Changes in the structure, abundance, and distribution of caddisfly larvae along the main courses of the river basin in relation to selected physicochemical variables were studied. Samples were obtained during all four seasons of the year on twenty-one sites in the main river and its tributaries. Species diversity was measured using the Shannon-Weaver index. Four main areas were identified in the river basin based on trichopteran taxa: (1) small intermittent streams and the first site of the main river, (2) the higher parts of small af-fluents, (3) the permanent upper part of the main river together with the lower site of a small tribu-tary drawing to this river at its upper part, and (4) there together with the lower site of a small ributary draining to this river at its upper part, and (4) the middle and lower parts of the main river as well as small tributaries entering this river in its lower part. Area 1 was characterized by individuals of Rhyncophila eatoni, Plectrocnemia conuals of Rhyncophila eatoni, Plectrocnemia con-spersa and P. geniculata. Areas 2 and 3 had a relatively rich and diverse assemblage of different species of Rhyncophila, Hydroptila, Hydropsyche, Polycentropus flavomaculatus and Athripsodes braueri. Area 4 had hydropsychid larvae, mainly H. bulbifera and H. lobata which were predomi-nant downstream. Differences in trichopteran as-semblage structure were related to water flow, oxygen content of the water and increasing down-stream mineralization which indicated increasing pollution. (Medina-PTT)

ASSESSMENT OF WATER POLLUTION USING DIATOM COMMUNITY STRUCTURE AND SPECIES DISTRIBUTION—A CASE STUDY IN A TROPICAL RIVER BASIN.

Malaya Univ., Kuala Lumpur (Malaysia). Inst. for Advanced Studies

I. S. A. Nather Khan.

Internationale Revue der Gesamten Hydrobiologie IGHYAZ, Vol. 75, No. 3, p 317-338, 1990. 4 fig, 12 tab, 45 ref.

Descriptors: \*Diatoms, \*Malaysia, \*River basins, \*Species diversity, \*Tropical regions, \*Water pol-lution effects, Artificial substrates, Bioassay, Bioin-dicators, Biological studies, Distribution patterns.

Biological assessment of water pollution using diatom community structure and species distribu-

### Effects Of Pollution—Group 5C

tion was carried out in the Linggi River Basin, Malaysia which is polluted by various urban, industrial and agricultural wastes. A total of 86 diatom taxa belonging to 21 genera were recorded, from eight sampling stations located in the basin, of which is a property of the sample of the basin, of which is a property of the sample of the basin, of which is a property of the sample of the basin, of which is a property of the sample of which 70 species were found on artificial sub-strates; the remaining 16 species were recorded exclusively on natural substrates. The number of diatom species observed between the stations varied from 22-47 species. The dominant diatom varied from 22-47 species. The dominant diatom species in decreasing order of abundance were Eunotia vanheurckii, Nitzschia palea, Achnanthes minutissima. Gomphonema parvulum and Achnanthes minutissima. The most common clean water species were A. minutissima. A. linearis and Synedra rumpens. The most tolerant species were N. palea, followed by G. parvulum and Pinnularia braunii. E. vanheurckii and Navicula cryptocephala occurred in high densities at both unpolluted and product of the product of t polluted stations and were considered to be the common facultative or indifferent species. Al-though a large number of species were recorded at the unpolluted stations, an equivalent number of species were also found at the moderately polluted stations. However, the number of species was markedly reduced at grossly polluted stations. However, even though there was a marked variation in species association between the unpolluted and polluted stations, there was no such association among the polluted stations to distinguish the type and degree of pollution. (Author's abstract) W91-11404

USEFULNESS OF VARIOUS NUMERICAL METHODS FOR ASSESSING THE SPECIFIC EFFECTS OF POLLUTION ON AQUATIC

EFFECTS OF PULLUTION OF ACCOUNTS OF THE STATE OF T

Descriptors: \*Aquatic life, \*Pollution index, \*Statistical methods, \*Water pollution effects, Cluster analysis, Comparison studies, Data interpretation, Ecosystems, Germany, Mathematical analysis, Performance evaluation, Species composition, Statistical analysis, Performance evaluation, Pe

An extensive multidisciplinary study of a polluted harbor basin in Hamburg, Germany, was conducted using various methods to determine which staharbor basin in Hamburg, Germany, was conducted using various methods to determine which statistical methods are easiest to interpret and permit the most accurate evaluations. The methods analyzed include the species deficit, index of species similarity, saprobity index, and the more complex cluster and gradient analyses (which revealed a variety of relationships among the biotic communities at the various sampling sites and some ecological tolerance limits of various species). Some contradictory results were obtained using the simpler indices because species deficit takes no cognizance of the identities of the species encountered, while the index of species similarity does. Large discrepancies among the saprobity indices indicated that this index provides a basis for rough comparison with inaccurate characterization of water conditions due mainly to the occasional abundance of obiquitous species with broad tolerances that have been assigned arbitrary saprobity values. The cluster and gradient analyses revealed a variety of relationships among the biotic communities at the various sampling sites along with some ecological tolerance limits of various species. The results reveal the qualitative effects of influx of species from the Elbe and from the storm drains of Hamburg and confirm the destructiveness of organic nollutants which spread their effects seasonally from the Eule and from the storm drains of Hain-burg and confirm the destructiveness of organic pollutants which spread their effects seasonally from one part of the harbor. While it is evident that no one statistical method or index adequately that no one statistical method or index adequately represents the highly complex ecological condi-tions in a water body, using a variety of such methods to analyze sampling data provides many valuable insights into the processes taking place in the system. (Medina-PTT) W91-111406

VARIATION IN THE ACIDITY OF GROUND AND SURFACE WATERS IN NORTHERN IRE-LAND.

Department of Agriculture for Northern Ireland, Antrim. Freshwater Biological Investigation Unit. For primary bibliographic entry see Field 2H. W91-11407

PROXIMATE COMPOSITION AND NUTRI-ENT ELEMENTS IN THE UNUSUAL ALGAL JELLIES OF LAKE OGUTA IN SOUTHERN NIGERIA.

Port Harcourt Univ. (Nigeria). For primary bibliographic entry see Field 2H. W91-11408

EFFECTS OF SUSPENDED SEDIMENTS ON AQUATIC ECOSYSTEMS.

AQUATIC ECUSYSTEMS.
British Columbia Ministry of Environment, Victoria. Environmental Protection Div.
C. P. Newcombe, and D. D. MacDonald.
North American Journal of Fisheries Management
NAJMDP, Vol. 11, No. 1, p 72-82, Winter 1991. 2
fig. 5 tab, 54 ref.

Descriptors: \*Sediment concentration, \*Suspended sediments, \*Water pollution effects, Aquatic life, Fish, Pollution load.

Resource managers need to predict effects of pollution episodes on aquatic biota, and suspended sediment is an important variable in considerations of freshwater quality. Despite considerable research, there is little agreement on environmental effects of suspended sediment as a function of concentration and duration of exposure. More than 70 papers on the effects of inorganic suspended sediments on freshwater and marine fish and other organisms were reviewed to compile a date base. segments on resolvater and marine is and other organisms were reviewed to compile a data base on such effects. Regression analysis indicates that concentration alone is a relatively poor indicator of suspended sediment effects. The product of sediof suspended sediment effects. The product of sedi-ment concentration and duration of exposure is a better indicator of effects. An index of pollution intensity (stress index) is calculated by taking the natural logarithm of the product of concentration and duration. The stress index provides a conven-ient tool for predicting effects for a pollution epi-sode of known intensity. Aquatic biota respond to both the concentration of suspended sediments and duration of exposure much as they do for other duration of exposure, much as they do for other environmental contaminants. Researchers should, therefore, not only report concentration of sus-pended sediment but also duration of exposure of aquatic biota to suspended sediments. (Author's

APPROACHES TO THE SIMULATION OF RE-GIONAL CLIMATE CHANGE: A REVIEW. National Center for Atmospheric Research, Boul-

F. Giorgi, and L. O. Mearns. Reviews of Geophysics RVGPB4, Vol. 29, No. 2, p 191-216, May 1991. 15 fig, 1 tab, 123 ref.

Descriptors: \*Climatic changes, \*Climatology, \*Global warming, \*Greenhouse effect, \*Model studies, Atmospheric circulation, Instrumentation, Paleoclimatology, Regional analysis, Simulation,

The increasing awareness that enhanced levels of greenhouse gasses of direct or indirect anthropogenic origin might substantially change the climate of different regions of the world has rendered the issue of regional climate simulation critically important. The problem of projecting regional climate changes can be identified as that of representing effects of atmospheric forcings, i.e., forcings which modify the general circulation and determine the sequence of weather events which characterize the climate regime of a given region (for example, greenhouse gas abundance), and mesoscale forcings, i.e., forcings which modify local circulations, thereby regulating the regional distribution of climatic variables (for example complex mountain systems). General circulation models (GCMs) are the main tools available today for (GCMs) are the main tools available today for climate simulation. However, they are run and will likely be run for the next several years at resolu-tions which are too coarse to adequately describe

mesoscale forcings and yield accurate regional climate detail. These approaches can be divided into three broad categories: (1) Purely empirical approaches in which the forcings are not explicitly accounted for, but regional climate scenarios are constructed by using instrumental data records or paleoclimatic analogues; (2) semiempirical approaches, in which GCMs are used to describe the atmospheric response to large-scale forcings of relevance to climate changes, and empirical techniques account for the effect of mesoscale forcings; and (3) modeling approaches, in which mesoscale forcings are described by increasing the model resolution only over areas of interest. Since they are computationally inexpensive, empirical and semiempirical techniques have been more widely used. More recently, a nested GCM-limited area model has been developed with encouraging preliminary results and has a wide range of applications. (Medina-PTT) W91-11427

ARAL SEA BASIN: A CRITICAL ENVIRON-MENTAL ZONE.

Akademiya Nauk SSSR, Moscow. Inst. Geografii. For primary bibliographic entry see Field 6G. W91-11441

IMPACT OF A PULSE APPLICATION OF PER-METHRIN ON THE MACROINVERTEBRATE COMMUNITY OF A HEADWATER STREAM. Guelph Univ. (Ontario). Dept. of Environmental

Biology. P. K. Sibley, N. K. Kaushik, and D. P.

Kreutzweiser.
Environmental Pollution ENPOEK, Vol. 70, No. 1, p 35-55, 1991. 3 fig, 6 tab, 50 ref.

Descriptors: \*Ecological effects, \*Headwaters, \*Macroinvertebrates, \*Path of pollutants, \*Permethrins, \*Pesticide toxicity, \*Stream biota, \*Water pollution effects, Aquatic insects, Cadisfilies, Colonization, Flies, Mayflies, Ontario, Population density, Pyrethrins, Sampling, Species composition, Stoneflies.

The impact of a concentrated pulse (16 micrograms/L) of the pyrethroid insecticide permethrin (emulsifiable concentrate) was evaluated on the macroinvertebrate community of a northern Ontario headwater stream. Post-treatment drift increased by a factor of 2,400 within minutes of the arrival of the insection. the insecticide. There was a significant reduction in the abundance of invertebrates in most families as far as 260 m below the point of injection in both kick and artificial substrate samples. Greatest impact was observed in the mayflies Baetis flavistriga, Heptagenia flavescens, and Epeorus sp.; the stonefly Leuctra tenuis; and the caddisfly Dolophiclodes distinctus. Diptera were not significantly reduced. The number of species occurring 100 m from the point of injection was reduced by 47%, but only by 17% at 260 m. There was no change in the percent composition of functional feeding but only by 17% at 200 m. Incre was no change in the percent composition of functional feeding groups at any points after treatment. Recovery of most invertebrates was complete within 6 weeks of treatment. However, under of repeated exposures, as might be required for severe infestations by defoliating pests, the potential for long-term change in taxonomic and functional structure of a cnange in taxonomic and functional structure of a stream increases. The problem could be exacerbat-ed by the spraying of wide tracts of forests such that neighboring streams, also affected, could not provide a source of aerial recolonization for recov-ery of directly affected stream. (Doria-PTT) W91-11456

STUDIES ON THE EFFECTS OF SOME OR-GANIC POLLUTANTS ON THE HEAVY METAL TRANSPORT IN AN INDIAN SOIL. Aligarh Muslim Univ. (India). Dept. of Applied

Chemistry.
S. Kahn, N. N. Kahn, and N. Iqbal.
Environmental Pollution ENPOEK, Vol. 70, No.
2, p 109-115, 1991. 3 fig. 2 tab, 15 ref.

Descriptors: \*Heavy metals, \*Organic pollutants, \*Path of pollutants, \*Soil chemistry, \*Water pollution effects, Alcohols, Cadmium, Cobalt, Copper,

### **Group 5C—Effects Of Pollution**

Distilled water, Formaldehyde, India, Ketones, Loam, Mercury, Nickel, Sandy soils, Soil types, Thin layer chromatography, Zinc.

Thin layer chromatography was used to investi-gate the effect of organic pollutants such as alco-hols, ketones, and aldehydes on the mobility of heavy metals in an acidic sandy loam soil from neavy metais in an acidic sandy loam soil from Orissa (India). The mobility of metal ions (measured in R sub f units) was observed to increase in accordance with their decreasing radii except in the case of mercury. The addition of 5% alcohols in the developer (distilled water) increased the mobility of cobalt, nickel, zinc, and cadmium (except Cd in ethanol) while it decreased copper (except Cd in ethanol) while it decreased copper and mercury mobility (except copper in propanolamended developer). In a 5% formaldehyde water system, the mobility of all heavy metals studied increased significantly, except in the case of copper and mercury. In the acetaldehyde system, heavy metal mobility followed the formaldehyde pattern with 5% acetaldehyde. In the 5% benzaldehyde water system, the mobility of Cu, Hg, Co, and Cd decreased to about 0.1 R sub f units (mean) and then increased but remained lower than the condecreased to about 0.1 K sub 1 units (mean) and then increased, but remained lower than the control (distilled water). Acetone and ethyl methyl ketone decreased the mobility of Hg, Cu, and Cd, while cyclohexanone decreased Hg mobility by 0.07 and increased that of Cu and Cd by 0.03 and 0.04 R sub 1 units respectively. The mobility of 0.07 and increased that of Cu and Cd by 0.03 and 0.04 R sub f units, respectively. The mobility of Co, Ni, and Zn increased significantly in all ketone water systems. It is concluded that the blockage of soil adsorption sites by organic pollutants appears to enhance the mobility of heavy metals except in some cases at lower concentrations. (Doria-PTT) W91-11457

EFFECTS OF CHLORNITROFEN, A HERBI-CIDE, ON REPRODUCTION OF BRA-CHIONUS URCEOLARIS (ROTATORIA) THROUGH WATER AND FOOD (CHLOREL-

National Inst. for Environmental Studies, Ibaraki (Japan). Environmental Biology Div.

S. Hatakeyama.
Environmental Pollution ENPOEK, Vol. 70, No. 2, p 143-156, 1991. 3 fig, 3 tab, 33 ref.

Descriptors: \*Chlornitrofen, \*Herbicides, \*Pesticide toxicity, \*Reproduction, \*Water pollution effects, Algae, Chlorella, Eggs, Growth, Growth stages, Invertebrates, Lethal limit, Survival.

Chronic effects of chlornitrofen (CNP) on the reproduction of Brachionus urceolaris (Rotatoria) were investigated by exposure of individuals to CNP from the egg stage, which had been attached to the adult. The survivors of 12 neonates exposed to CNP (100, 70, or 40 micrograms/L) decreased to 50% at ages of 2, 4, and 6 days, respectively, compared to 6.5 days for those exposed to 1, 20, and 20 micrograms/L. Release of offspring (mostly 2 individuals/day) started at an age of 2 days. At the peak (4 d), a control female produced 8.1 offspring/d compared with 4.5 at 40 micrograms/L. The cumulative numbers of offspring produced by a female were 25.8, 24.2, 22.3, and 13.6 at control, 10, 20, and 40 micrograms/L, and 13.6 at control, 10, 20, and 40 micrograms/L, respectively. The 50% reproductive impairment concentration was calculated to be 37 micrograms/L. Growth of neonates was barely detectable at 70 micrograms/L, and the rapid increase in the effect of CNP from 40 to 70 micrograms/L was attributed to an increase in tolerance with growth of the neonates. The effects of CNP on reproduction were tested by CNP exposure through food (CNP-accumulated Chlorella). The 50% reproductive impairment concentration of CNP in the alga was calculated to be 600 micrograms/g (wet weight) by the same method used to assess the dissolved CNP, although the effect of CNP that may have been released from the alga to the water could not be estimated precisely. (Author's abstract) Chronic effects of chlornitrofen (CNP) on the re-

EUTROPHICATION OF PULP AND PAPER

EUTROPHICATION OF PULP AND PAPER WASTEWATER RECIPIENTS.
Soil and Water Ltd., Helsinki (Finland).
J. Wartiovaara, and P. Heinonen.
Water Science and Technology WSTED4, Vol.
24, No. 3/4, p 411-415, 1991. 2 tab, 6 ref.

Descriptors: \*Environmental effects, \*Eutrophica-tion, \*Pulp and paper industry, \*Pulp wastes, \*Water pollution effects, \*Water pollution sources, Biological oxygen demand, Biological treatment, Bleaching wastes, Industrial wastes, Nitrogen, Phosphorus.

During recent years the biological oxygen demand-loading of pulp and paper mill wastewaters has decreased dramatically, due to more effective circulation of water in the processmore effective circulation of water in the process-es, and the new activated sludge biological treat-ment plants. This traditional threat to the environ-ment has been forgotten by the scientists who are currently more concerned with the role of chlorine compounds discharged from bleaching processes. However, eutrophication due to nutrient loading is still present in many recipient waters of pulp and paper industry effluents. The biological oxygen demand reduction has often been carried out at the cost of adding nutrients, phosphorus and nitrogen, to the purification processes. Biological treatment has decreased the inhibitive effect of wastewater on the biological production of the recipient water body, thus causing eutrophication to arise immedi-ately. There has been a remarkable and extensive ately. There has been a remarkable and extensive development in the prevention of eutrophication of pulp and paper wastewater recipient water bodies. Treatment has been carried out effectively, from suspended solids to oxygen demand, to the decrease in phosphorus loading and management of collorinated compounds. Eutrophication remains, however, a very real problem. (See also W91-11467) (Mertz-PTT) W91-11509

SAPROBIOLOGICAL INVESTIGATIONS ON THE BOTTOM FLORA OF THE RIVER RECK-NITZ IN THE NORTHERN PART OF THE MECKLENBURGIAN LAKE DISTRICT (GDR) (SAPROBIOLOGISCHE UNTERSUCHUNGEN AN DER BENTHOSFLORA DER RECKNITZ IM NORDEN DER MECKLENBURGER SEEN-PLATTE (DDR)).

Rostock Univ. (German D.R.). Dept. of Biology. For primary bibliographic entry see Field 2E. W91-11520

HYDROBIOLOGICAL SURVEY OF THE CHANOMI CREEK SYSTEM, LOWER NIGER DELTA, NIGERIA.

Port Harcourt Univ. (Nigeria). Dept. of Zoology.

C. Nwadiaro. Limnologica LMNOA8, Vol. 21, No. 1, p 263-274, October 1990. 2 fig, 8 tab, 61 ref.

Descriptors: \*Biological studies, \*Estuaries, \*Lim-Descriptors: \*Biological studies, \*Estuaries, \*Lim-nology, \*Niger River Basin, \*Oil spills, \*Streams, \*Water pollution effects, Alkalinity, Barnacles, Bi-ological oxygen demand, Chlorophyll a, Cope-pods, Diatoms, Dinoflagellates, Dissolved oxygen, Dissolved solids, Ecotoxicology, Environmental effects, Gastropods, Hydrogen ion concentration, Phytoplankton, Polychaetes, Productivity, Shrimp, Species diversity, Transparency, Water depth,

Chanomi Creek, an estuarine system in the lower Niger delta of Nigeria, was evaluated between December 1984 and April 1985, to ascertain how far the system had recovered approximately three far the system had recovered approximately three years after some areas had been damaged by a crude oil spill. Hydrobiological indices had ranges of: pH, 6.8 to 8.1; depth, from 2.65 m to > 15 m; temperature, 24 C to 29 C; transparency, 0.75-1.75 m; alkalinity, 1.10-1.53 microeq/L; total dissolved solids, 11.1-32.0 mg/L; dissolved oxygen, 7-13 mg O2/L; percentage oxygen saturation, 94% to 6.65 solids, 11.1-32.0 mg/L; dissolved oxygen, 7-13 mg O2/L; percentage oxygen saturation, 94% to 155%; and a 24-hr biological oxygen demand (25 c), 0.17-3.66 mg O2/L; mean chlorophyll a, 3.55 mg/cu m to 9.43 mg/cu m; and, gross phytoplankton productivity, 40-813 mg O2/L/h. Phytoplankton consisted predominantly of diatoms (over 41 species), followed by dinoflagellates (7 species). Zooplankton density was high (42,877-527,708 organisms/10 min, 5 knot/h tow), with populations of adult calanoid and cylcopoid copepods, copepod nauplii, barnacle nauplii, larvaceans, and larvae of polychaetes, gastropods, and shrimp. There is some evidence that Chanomi Creek has recovered from the 1982 oil spill. (Doria-PTT)

W91-11524

RISE AND FALL OF THE POTOMAC RIVER STRIPED BASS STOCK: A HYPOTHESIS OF THE ROLE OF SEWAGE.

Maryland Univ., Solomons. Chesapeake Biological

C. Tsai, M. Wiley, and A. Chai.

Transactions of the American Fisheries Society TAFSAI, Vol. 120, No. 1, p 1-22, January 1991. 16 fig, 1 tab, 86 ref.

Descriptors: \*Bass, \*Estuarine fisheries, \*Fish populations, \*Potomac Estuary, \*Spawning, \*Wastewater facilities, \*Wastewater pollution, ontrol, \*Water pollution control, \*Water pollution effects, Biological oxygen demand, Fertility, Fish larvae, Growth stages, Model studies, Nutrients, Phytoplankton, Zooplankton.

The spawning and nursery area of striped bass Morone saxatilis in the Potomac River is located about 30 km downstream from the outfall of the Blue Plains sewage treatment plant in Washington, D. C. The area coincides with the fertile zone of the river that receives sewage from several treat-ment plants and has abundant phytoplankton and zooplankton. During the striped bass spawning season, April to June, there is a longitudinal downseason, April to June, there is a longitudinal down-river succession of sewage nutrients, phytoplank-ton, zooplankton, and striped bass larvae, suggest-ing the presence of a trophic link between sewage nutrients and larvae. A transfer function-noise model of average daily biological oxygen demand loadings from sewage treatment plants and the total commercial landings of striped bass from 1938 to 1983 was developed. The model suggests a causal relationship between the sewage nutrients and the fishery. A multiplicative decomposition and the fishery. A multiplicative decomposition analysis of striped bass juvenile indices from 1958 to 1986 suggests that sewage nutrients play an important role in recruitment. It is hypothesized that an increase in sewage raised the fertility of the spawning and nursery regions and was responsible for the abundance of striped bass from the 1940s through the 1960s. It is further hypothesized that improvements in sewage treatment processes since the early 1970s have greatly lowered sewage nutri-ent loading, lowered fertility in the spawning and nursery regions, and contributed to the recent de-cline of striped bass in the Potomac Estuary. (Author's abstract) W91-11529

CHEMICAL AND BIOLOGICAL FACTORS AFFECTING ACID TOLERANCE OF SMALL-MOUTH BASS.

Ontario Ministry of Natural Resources, Maple. Fisheries Branch

B. J. Shuter, and P. E. Ihssen.

Transactions of the American Fisheries Society TAFSAI, Vol. 120, No. 1, p 23-33, January 1991. 3 fig, 4 tab, 15 ref.

Descriptors: "Acid rain effects, "Acidity, "Bass, "Fish physiology, "Laboratory methods, "Water pollution effects, Calcium, Experimental design, Fish, Growth stages, Hydrogen ion concentration, Snowmelt, Sodium, Survival, Temperature.

The effects of starvation on acid tolerance of young-of-year smallmouth Micropterus dolomieui were investigated in the laboratory. Juvenile smallmouth bass, held under simulated winter conditions for up to 5 months, experienced losses in ashfree dry weight of up to 30%. However, consecutive tests failed to demonstrate any decline in the short-term (up to 7 d) tolerance of these fish for pH levels in the range from 3.0 to 4.5. Results confirm that hypersensitivity to short-term, very low pH exposure is of no significance under conditions (winter duration, temperature, fish size) typicals. low pit exposure is or no significance under condi-tions (winter duration, temperature, fish size) typi-cal of populations in south-central Ontario. The duration of the winter starvation period typically experienced by such populations is too short to affect their ability to withstand the severe, short-term pH depressions that often accompany spring snowmelt. Calcium and sodium concentration of the water and fish body size (fork length) were all positively related to acid tolerance. A doubling of

### Effects Of Pollution—Group 5C

fork length increased survival time at any pH by 100%. At pH 3.0, a doubling of calcium concentration increased survival time by 13% and at pH 4.0 it increased survival time by 50%. Over the pH range 3.75 to 4.0, doubling sodium concentration increased survival time by 8%. The effect of body size on acid tolerance should be recognized and controlled in future experiments and when laboratory tolerance estimates are used to assess the susceptibility of wild populations to acid stress. (Author's abstract) (Author's abstract) W91-11530

SENSITIVITY OF GREENBACK CUTTHROAT TROUT TO ACIDIC PH AND ELEVATED ALU-

MINUM.

National Fisheries Contaminant Research Center,
Jackson, WY. Jackson Field Station.

D. F. Woodward, A. M. Farag, E. E. Little, B.
Steadman, and R. Yancik.

Transactions of the American Fisheries Society
TAFSAI, Vol. 120, No. 1, p 34-42, January 1991. 6
tab, 43 ref. U. S. Forest Service Cooperative
Agreement 28, C6-382 Agreement 28-C6-382.

Descriptors: \*Acid rain effects, \*Aluminum, \*En-Accomptors: "Actor ram effects, "Aluminum, "Endangered species, "Trout, "Water pollution effects, Acidity, Arkansas River, Colorado, Embryonic growth stage, Fish, Fish eggs, Growth stages, Hydrogen ion concentration, Larval growth stage, South Platte River, Survival.

The greenback cutthroat trout Oncorhynchus clarki stomias is a threatened subspecies native to the upper South Platte and Arkansas rivers between Denver and Fort Collins, Colorado, an area also susceptible to acid deposition. In laboratory studies, this subspecies was exposed to nominal pHs of 4.5-6.5 and to nominal aluminum concentrapris of 4.3-0.3 and to infilm a dufiniting contents of the control was pH 6.5 treatment without Al. Soft water was used that contained 1.3 mg Ca/L. Exposures of 7 d each were made for four early life stages: fertilized egg, eyed embryo, alevin, and swim-up larva. Effects were measured at the end swim-up larva. Effects were measured at the end of exposure and again after a recovery period lasting until 40 d posthatch. The alevin stage was the most sensitive: at pH 5.0 with no Al, survival was reduced by 68% and swimming duration by 76%; at pH 6.0 and 50 micrograms Al/L, swimming duration was reduced by 62%, but survival was not affected. Reductions in whole-body conwas not affected. Reductions in whole-body concentrations of Na, K, and Ca indicated organism stress. Sodium was reduced most: about 50% in alevins exposed to pH 5.0 without Al and to pH 6.0 with 50 micrograms Al/L. Growth and the ratio of RNA to DNA were not affected by any exposure. All responses that were affected during exposure returned to normal by 40 d posthatch. Overall, it appeared that pH 6.0 and 50 micrograms Al/L might be detrimental to greenback cutthroat trout populations. (Author's abstract) W91-11531

SEDIMENT DENITRIFICATION POTENTIAL IN THE ELIZABETH RIVER, VIRGINIA.
Old Dominion Univ., Norfolk, VA. Dept. of Bio-

logical Sciences.
S. Fazeli-Matin, A. S. Gordon, and H. G.

Virginia Journal of Science VJSCAI, Vol. 42, No. 1, p 113-122, Spring 1991. 5 fig, 17 ref.

Descriptors: \*Denitrification, \*Elizabeth River, \*Sediment chemistry, \*Sediment contamination, \*Water pollution effects, Algal blooms, Dissolved oxygen, Nitrates, Phytoplankton, Seasonal variation, Temperature, Virginia.

Sediment denitrification potential from two sites in Sediment dentrinication potential from two sites in the Elizabeth River estuary was studied over a 9-month period using the acetylene blockage method. Rates of microbial processes in this envi-ronment are of interest because of the high concentration of toxics present in some parts of the system. Highest rates were found in the highly polluted Southern Branch of the Elizabeth River with nitrate-amended sediment ranging from 2 to 262 nmol N2O/h/20 ml of sediment and exhibiting maximal rates during spring and fall. Rates in the Main Stem of the Elizabeth River are lower, with

less than 1-85 nmol N2O/h/20 ml in nitrate-amendless than 1-85 nmol N2O/h/20 ml in nitrate-amended sediment, and maxima in late fall. Unamended sediment denitrified only minimally in the spring. Sediment denitrification potential was independent of temperature and dissolved oxygen in the water column. Comparison of phytoplankton abundance values and potential denitrification protential may be stimulated by phytoplankton bloom senescence. Comparison to other published studies shows sediment denitrification potential in the Elizabeth River to be within tion potential in the Elizabeth River to be within the range of values reported for other environ-ments. Denitrification potential in the sediments is, therefore, maintained in the presence of toxics in the sediment. (Author's abstra W91-11537

HAZARD ASSESSMENT RESEARCH STRATE-GY FOR OCEAN DISPOSAL.

Environmental Research Lab., Narragansett, RI. For primary bibliographic entry see Field 5E.

INTERPRETATION OF HYDROLOGIC EF-FECTS OF CLIMATE CHANGE IN THE SAC-RAMENTO-SAN JOAQUIN RIVER BASIN,

Washington Univ., Seattle. Dept. of Civil Engineering.

D. P. Lettenmaier, T. Y. Gan, and D. R. Dawdy. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-136987. Price codes: A06 in paper copy, A01 in microfiche. Report No. Water Resources Ser/TR-110, June 1988. 11p, 13 fig, 15 tab, 19 ref, 3 append.

Descriptors: \*Global warming, \*Hydrologic budget, \*Climate effects, \*Sacramento River Basin, \*San Joaquin River Basin, \*Model studies, California, Snow, Ablation, Runoff, Simulation analysis, Snowmett, Seasonal variation, Data inter-pretation, Temperature, Precipitation.

Climatic changes were studied in four catchments with areas ranging from 203 to 358 sq mi, in the headwaters of the Sacramento-San Joaquin Basin. Three of the study catchments, The McCloud River, the North Fork American River, and Thomas Creek, lie in the Sacramento River Basin; one, the Merced River, is in the San Joaquin basin. Snow accumulation and ablation, and runoff were simulated under current (and historical) conditions simulated under current (an instorical) conditions using the National Weather Service snowmelt and soil moisture accounting models. The snowmelt model operated on a six hourly time step, while the soil moisture accounting model operated on a daily time step. Once the models were calibrated to present conditions, simulations were performed under seven alternative climate scenarios. All simunder seven aiternative climate scenarios. All similations were performed using 100 yrs of daily temperature and precipitation data (disaggregated to a six hourly interval for the snowmelt model) consisting of the years 1951-80 supplemented by 70 additional years drawn at random from the 1951-80 record. All of the initial scenarios (based on steady state CO2 doubling, or a transient from present conditions to CO2 doubling) showed that the simulated hydrologic changes were dominated by a shift in the snow accumulation pattern. For all but the highest catchment (the Merced), this resulted the highest catchment (the Merced), this resuited in a change from a snow-dominated to a rainfall-dominated hydrologic regime. Long-term runoff was shifted from the spring to the winter. Spring and summer mean runoffs were greatly reduced. In addition, the soil moisture in the winter months increased, and decreased in the spring and summer. increased, and decreased in the spring and summer. Because of the evaporation in the spring, there was a shift in maximum evapotranspiration earlier in the season. These general shifts were observed for all of the alternative climates. They were most severe for the Geophysical Fluid Dynamics Laboratory (GFDL) and Goddard Institute for Space Studies (GISS) CO2 doubling scenarios, for which the temperature shifts were the greatest, and were least severe for the Oregon State University (OSU) model CO2 doubling, for which the predicted temperature increases were < 1/2 those for the GISS and GFDL models for most months. (Lantz-PTT) W91\_1155.

MECHANISMS OF RESISTANCE TO POLY-CHLORINATED BIPHENYLS (PCB) IN TWO SPECIES OF MARINE DIATOMS.

State Univ. of New York at Stony Brook. Marine Sciences Research Center.

M. K. Cohen, A. S. West, E. M. Cosper, and C. F.

Journal of the Marine Biological Association of the United Kingdom JMBAAK, Vol. 71, No. 2, p 247-263, May 1991. 7 fig, 3 tab, 39 ref.

Descriptors: \*Water pollution effects, \*Microbiological studies, \*Polychlorinated \*Marine environment, \*Diatoms, \*Resistance, \*Hudson River estuary, Physiological ecology, Lipids, Bioaccumulation, Food chains.

Clones of Ditylum brightwellii and Thalassiosira nordenskioldii were isolated from New York coastal waters, and PCB-resistance in D. brightwellii was induced in the laboratory by exposure to increasing concentrations of PCB. Resistance could not be similarly induced in T. nordenskioldii but was segrediptiously discovered in unexposure of the property of the proper kioldii, but was serendipitously discovered in unex-posed cultures that had undergone sexual repro-duction. Cells of the resistant strain were substantally larger than those of the sensitivity strain in both species. Larger vacuole space seemed to account for this in D. bright wellij, but in T. nordensitoldij, larger cells contained more carbon. Experiments with 14-C-PCB tracer indicated that PCB accumulation was less in resistant strains of both species. Neutral lipid content/cell, as determined species. Neutral lipid collection. Veil, as determined using the fluorophore Nile Red, was similar for resistant and sensitive strains of both species. Subcellularr examination of lipid droplets in D. brightwellii suggested that the PCB-resistant strain brightwelli suggested that the PCB-resistant strain may be sequestering this lipophilic toxicant in a location removed from physiological activity. In T. nordenskioldii a decreased ratio of neutral lipid:carbon may reduce intracellular accumulation of PCB. These diatom species have developed PCB resistance in the highly PCB-polluted Hudson River estuary and, since they are the preferred food of dominant copepods, they may offer less PCB per unit ration to zooplankton grazers. (Author's abstract) abstract)

ASSESSING THE RESPONSE OF EMERALD LAKE, AN ALPINE WATERSHED IN SEQUOIA NATIONAL PARK, CALIFORNIA, TO ACIDIFICATION DURING SNOWMELT BUSING A SIMPLE HYDROCHEMICAL

Geological Survey, Doraville, GA. Water Res Div.

R. P. Hooper, C. T. West, and N. E. Peters. Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 90-4000, 1990. 68p, 10 fig, 4 tab, 27 ref, 2 append.

Descriptors: \*Acid rain, \*Acidification, \*Emerald Lake, \*Lake acidification, \*Model studies, \*Snow-melt, \*Water chemistry, \*Water pollution effects, California, Computer programs, Sulfates, Weather-

A sparsely parameterized hydrochemical model has been developed by using data from Emerald Lake watershed, which is a 120-ha alpine catch-Lake watershed, which is a 120-ha alpine catchment in Sequoia National Park, California. Greater than 90% of the precipitation to this watershed is snow; hence, snowmelt is the dominant hydrologic event. A model which uses a single alkalinity-generating mechanism, primary mineral weathering, was able to capture the pattern of solute concentrations in surface waters during snowmellt. An empirical representation of the weathering reaction, which is based on rock weathering stoichimetry and which uses discharge as a measure of action, which is based on rock weathering stoichi-ometry and which uses discharge as a measure of residence time, was included in the model. Results of the model indicate that current deposition levels would have to be increased between three-fold and eight-fold to exhaust the alkalinity of the lake during snowmelt if there is a mild acidic pulse in the stream at the beginning of snowmelt as was observed during the study period. The acidic pulse in the inflow stream at the onset of snowmelt was less pronounced than acidic pulses observed in the

### **Group 5C—Effects Of Pollution**

meltwater draining the snowpack at a point using snow lysimeters or in the laboratory. Sulfate con-centrations in the stream water were the most constant: chloride and nitrate concentrations inconstant; circular and initiate concentrations in-creased slightly at the beginning of snowmelt. Ad-ditional field work is required to resolve whether an acidic meltwater pulse occurs over a large area an action mentwater puise occurs over a large area as well as at a point (implying sulfate-regulating mechanisms in the soil) or whether, due to physical and chemical processes within the snowpack, the acidic meltwater pulse is attenuated at the catchment scale. The modest data requirements of the model permit its applications to other alpine water-sheds that are much less intensively studied than Emerald Lake watershed. (Author's abstract)

### 5D. Waste Treatment Processes

BOSTON'S SEWAGE OUTFALL.

D. T. Palmer.

Civil Engineering (ASCE) CEWRA9, Vol. 61, No. 4, p 74-76, April 1991. 2 fig.

Descriptors: \*Boston, \*Construction, \*Massachusetts, \*Municipal wastewater, \*Outfall sewers, \*Wastewater facilities, \*Wastewater treatment, \*Water pollution prevention, Rapid excavation, Tunnel construction, Tunneling, Wastewater out-

It took centuries of neglect to make Boston Harbor the nation's dirtiest. Now the city has nine years to the nation's dirtiest. Now the city has nine years to clean up. The Deer Island wastewater treatment plant will be the centerpiece of the \$6 billion cleanup effort. Making the plant effective and completing the project on time means fast-tracking the design and geotechnical work, and boring a 10 mile outfall tunnel at record speed. Presently, undersized and outdated plants on Deer and Nut islands provide minimal treatment to Boston area sewage. Two cross-harbor tunnels carry samples provide minimal treatment to boston area sewage. Two cross-harbor tunnels carry wastewater to the existing Deer Island plant. When the new plant is built, sewage that presently goes to the Nut Island plant will bypass it and flow across the harbor through a new tunnel, 12 feet in across the harbor through a new tunnel, 12 feet in diameter. Together, the three tunnels and the new plant will serve 43 municipalities. The Deer Island facility's peak capacity of 1270 million gallons/day will make it the second largest in the U.S. In order to meet the court-mandated deadlines, the tunnel boring machine will have to set a record pace. Tunneling and offshore drilling are both high-risk work; this project will mix the two when the tunnel is being connected to its risers. Three safety barriers will be used in the connection area: water tight caps on the diffuser nozzles; a plug in each riser, to be removed only after the breakthrough from the tunnel is made and checks for leaks have been carried out; and a bulkhead in each riser offtake. All barriers will be removed at various stages of constructions or that the outfall can function. After the tunnel is completed it will be filled tion. After the tunnel is completed it will be filled from the shaft end with clean, chlorinated seawater from the snart end with clean, chlorinated seawater to prevent biofouling. When the tunnel risers are full, crews will remove port caps. The treated effluent will then be diverted to the shaft, purging the outfall of seawater before discharging into the bay. (Mertz-PTT) W91-10485

USE OF RESPIRATION IN THE SANDY BEACH OR ON THE TIDAL FLAT: 1. PERMEABLE SANDY BEACH.

Shin Nippon METOCEAN Consultant Co., Ltd., Edobori 3-2-23, Nishi-ku, Osaka, 550 Japan. For primary bibliographic entry see Field 5G. W91-10541

MEASURES FOR PURIFICATION OF THE LEACHATE FROM 'RENSEANLAEG DAMHU-SAEN' INTO COPENHAGEN WATERS, TO MEET THE NPO-PLAN.

Danmarks Ingenioerakademi, Lyngby. Kemiafde-

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 703-706, 1991. 3 fig, 2 tab, 8 ref.

Descriptors: \*Copenhagen, \*Denmark, \*Lea-chates, \*Marine environment, \*Wastewater treat-ment, \*Water pollution control, \*Water pollution ment, "water politution control," water politution treatment, Biological wastewater treatment, Environmental protection, Nitrogen removal, Ocean dumping, Organic matter, Phosphorus removal, Wastewater disposal.

Measures to reduce the leaching of organic material and nitrogen compounds from the land area at 'Renseanlaeg Damhusaen' sewage plant were compared. The Danish NPO-Plan of 1987, designed to protect the marine environment, has the following goals: (1) all waste water should be treated to remove organics, nitrogen and phosphorus, before discharge to the ocean; and (2) nitrogen loads on the ocean from Denmark should be reduced by 50% and the phosphorus loads by 80%. Suggested measures are either total leachate collection followed by biological treatment or selected leachate collection and treatment, followed by distribution of 'high-N' water for domestic use other than drinking. The latter solution will, if generally used, protect groundwater resources as well as marine life. (Brunone-PTT) W91-10601

STUDY OF CAMPYLOBACTER IN SEWAGE. SEWAGE SLUDGE AND IN RIVER WATER. Forschungsinstitut fuer Mikrobiologie und Hygiene, Bad Elster (German D.R.). W. Stelzer, and J. Jacob.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 117-120, 1991. 4 tab, 7 ref.

Descriptors: \*Bacterial analysis, \*Campylobacter, \*Germany, \*Path of pollutants, \*River systems, \*Sludge, \*Wastewater, \*Water analysis, \*Water pollution sources, Agars, Culture media, Culturing techniques, Digested sludge, Electrophoresis, Farm wastes, Feces, Oxidation ponds, Poultry, Survival, Temperature effects, Water quality, Waterfowl.

The occurrence of campylobacters was determined Ine occurrence of campylobacters was determined in wastewater and sewage sludge and in the river system Weisse Elster (Germany). The selective medium used consisted of blood agar supplemented with the antibiotics vancomycin, cephalexin, trimethoprim, polymycin B, and rifampicin. Raw sewage samples contained about 1,000 Campylobacter/100 ml, while the effluent showed an average statistics of 130/1001 and Provinces. bacter/100 ml, while the effluent showed an aver-age concentration of 130/100 ml. Raw sewage from an oxidation pond contained an average of 51 Campylobacter/100 ml, while none were found in the effluent. No Campylobacter could be found in digested, conditioned studge. The organism could be detected in 82.1% of river waters examined, with the majority showing < 10/100 ml. The pres-ence of waterfowl and fecal contamination from a poultry farm resulted in higher Campylobacter levels About 50% of the isolates typed as C. Cellipoultry farm resulted in higher Campylobacter levels. About 50% of the isolates typed as C. oli were confirmed as C. jejuni by electrophoretic pattern (whole cell protein profiles). Campylobacter test strains survived only a few hours at 37 C and up to a few days at 20 C. Survival was up to several weeks in some cases at low temperatures. Survival in sewage sludge ranged from hours to 10 days. These results must be viewed in the light of the occurrence in Campylobacter of a viable nonculturable stage. The fractions of dead cells and of viable nonculturable cells is unknown under environmental conditions. The health risk posed by ronmental conditions. The health risk posed by viable nonculturable Campylobacter is also un-known. (See also W91-10612) (Doria-PTT) 91-10634

DISTRIBUTION OF GIARDIA CYSTS IN WASTEWATER. Pittsburgh Univ., PA. Graduate School of Public

For primary bibliographic entry see Field 5B. W91-10649

RECOVERY OF ENTEROVIRUS FROM PRIMARY SLUDGE USING THREE ELUTION CONCENTRATION PROCEDURES.

Nancy-1 Univ. (France). Faculte de Pharmacie. For primary ibiliographic entry see Field 5A. W91-10657

POLYVALENT COLIPHAGES IN SEWAGE.

Bahrain Univ., Manama. Dept. of Biology. For primary bibliographic entry see Field 5A.

DISINFECTION OF SECONDARY EF-JENTS FROM SEWAGE TREATMENT PLANTS.

Bayerische Landesanstalt fuer Wasserforschung, Munich (Germany, F.R.)

Water Science and Technology WSTED4, Vol. 24, No. 2, p 343-346, 1991. 4 fig, 3 ref.

Descriptors: \*Bacteria, \*Disinfection, \*Secondary wastewater, \*Ultraviolet radiation, \*Wastewater treatment, Acinetobacter, Aerobic bacteria, Coliforms, Culturing techniques, Effluents, Fecal coliforms, Fecal streptococci, Germany, Munich, Pilot plants, Sewage bacteria.

Pilot plant experiments were conducted on the effect of ultraviolet (UV) irradiation on secondary effluent from a wastewater treatment plant near Munich (Germany). UV disinfection led to a good reduction of bacterial concentration. At a flow rate reduction of bacterial concentration. At a flow rate of 50 cu m/h, the logarithms of mean reduction rates were 4.2 for total coliforms, 4.3 for fecal coliforms, 3.8 for fecal streptococci, and 3.4 for standard plate count. At a flow rate of 150 cu m/h, the logarithms of mean reduction rates were 3.0 for total coliforms, 3.3 for fecal coliforms, 2.5 for fecal streptococci, and 2.4 for standard plate count. The reduction rates of total and fecal coliforms were similar. Fecal streptococci and plate count bacteria were less sensitive to UV irradiation than coliforms. The log reduction rate of fecal streptococci was about 0.5 lower and that of plate count bacteria about 0.8 lower than that of coliforms. Within the group of dominant aerobic wastewater bactethe group of dominant aerobic wastewater bacteria, the reduction rates differ more from one another than within the group of fecal indicator bacteria. Enterobacters ( $(g\ r)=3.5$ ) and strains of Acinetobacter ( $(g\ r)=3.3$ ) were most sensitive to UV irradiation. Coryneform bacteria showed the lowest reduction rate ( $(g\ r)=0.8$ ). Differing UV sensitivities of these bacteria led to a population shift under UV treatment. The results indicate that the application of UV disinfection in full-scale wastewater treatment plants is promising. (See also W91-10612) (Doria-PTT) the group of dominant aerobic wastewater bacte-W91-10681

F-SPECIFIC RNA BACTERIOPHAGES AS MODEL VIRUSES IN UV DISINFECTION OF WASTEWATER.

Rijksinstituut voor de Volksgezondheid, Bilthoven (Netherlands). Lab. for Water and Food Microbi-

ology.
A. H. Havelaar, T. J. Nieuwstad, C. C. E.
Meulemans, and M. van Olphen.
Water Science and Technology WSTED4, Vol.
24, No. 2, p 347-352, 1991. 3 fig, 1 tab, 5 ref.

Descriptors: \*Bacteriophage, \*Bioindicators, \*Dis-infection, \*Ultraviolet radiation, \*Viruses, \*Wastewater treatment, Absorption, Assay, Es-cherichia coli, Fecal streptococci, Indicators, Ki-netics, Monitoring, Performance efficiency, RNA, Wastewater facilities.

Designing ultraviolet (UV) reactors for inactivation of viruses in treated wastewater requires field data on UV resistance of these organisms. It would therefore be desirable to have a simple model organism that can be assayed frequently, at low cost, and with rapid results. The F-specific RNA (FRNA) bacteriophages were investigated as potential process indicators for the design and monitoring of UV reactors. FRNA bacteriophages can be assayed in wastewater by simple and rapid methods. Their inactivation by UV radiation follows first-order kinetics and relatively simple formulas can describe the effect of UV absorbance by wastewater and the wavelength-dependent killing mulas can describe the effect of UV absorbance by wastewater and the wavelength-dependent killing efficiency of polychromatic lamps. Because the organisms can be grown in high concentrations, biological calibration of full-scale reactors requires only relatively small volumes of phage culture. Naturally occurring FRNA phages were more re-

### Waste Treatment Processes—Group 5D

sistant to UV than somatic coliphages, Escherichia coli, and fecal streptococci. The inactivation rate constant was almost equal to that of reoviruses, which underlines the suitability of FRNA phages as a process indicator for UV inactivation of viruses. A pure culture of MS2 was inactivated at a rate almost twice that of naturally occurring FRNA phages, indicating the necessity of designing reactors for practical applications on field data rather than laboratory experiments. (See also W91-10612) (Doria-PTT)

ACTIVITY OF PERACETIC ACID ON SEWAGE INDICATOR BACTERIA AND VIRUSES, Interox S.A., Widnes (England). Research and De-

velopment.
M. G. C. Baldry, M. S. French, and D. Slater.
Water Science and Technology WSTED4, Vol.
24, No. 2, p 353-357, 1991. 3 tab, 11 ref.

Descriptors: \*Bacteria, \*Chlorine, \*Disinfection, \*Peracetic acid, \*Viruses, \*Wastewater treatment, Acidity, Bacteriophage, Bioindicators, Comparison studies, Organic matter, Oxygen, Performance evaluation, Yeasts.

Studies were undertaken to establish the comparative effects of peracetic acid (PAA) and chlorine on bacteria and viruses. Results show that, against both bacteria and phage, PAA is very effective in clean systems, and retains some activity in the presence of organic soiling. Although the activity of PAA was best under mildly acidic conditions, of PAA was best under mildly acidic conditions, good antimicrobial action was also seen at neutral pH. The poliovirus used was much more resistant to PAA than were the phages and the bacteria. However, the concentration of PAA required for a given reduction in viral numbers is little changed in the presence of organic matter. For example, the concentration of PAA required to bring about a 99.99% reduction in the concentration of poliovirus in the presence of yeast extract was typically 1.5 to 2 times the concentration necessary in a rus in the presence of yeast extract was typically 1.5 to 2 times the concentration necessary in a clean system. In the presence of yeast extract, identical performances against poliovirus were obtained using 2,000 mg/L available chlorine or 2,250 mg/L PAA (470 mg/L available chlorine or 2,250 mg/L PAA (470 mg/L available chlorine or 10 minutes, or 750 mg/L PAA (160 mg/L available oxygen) with a contact time of 10 minutes, or 750 mg/L available over a five minute contact time were 2,000 mg/L available chlorine compared to 94-113 mg/L PAA (20-24 mg/L) available oxygen). These results indicate that PAA is effective against bacteria, phage, and viruses. In contrast to chlorine, PAA is little affected by organic matter, and viral inactivation continues up to one hour after PAA addition. (See also W91-10612) (Doria-PTT) W91-10682)

OCCURRENCE OF V. CHOLERAE 0:1 NON-TOXIGENIC IN WASTEWATERS FROM SAO PAULO, BRAZIL.
Sao Paulo Univ. (Brazil). Inst. de Ciencias Biome-

dicas.
M. T. Martins, G. V. A. Pessoa, P. S. Sanchez, M. I. Z. Sato, and C. A. Coimbrao.
Water Science and Technology WSTED4, Vol. 24, No. 2, p 363-366, 1991. 1 tab, 26 ref.

Descriptors: \*Brazil, \*Human diseases, \*Pathogen-ic bacteria, \*Sao Paulo, \*Vibrio, Bacterial analysis, Bacterial toxins, Culturing techniques, Public health, Wastewater analysis, Wastewater irrigation, Water quality monitoring.

In the State of Sao Paulo, Brazil, a program of cholera surveillance was undertaken between September 1974 and December 1983, analyzing sewage samples for the presence of Vibrio cholerae 0:1 to evaluate the possible circulation of this agent in the community. Of 12,867 samples analyzed, four were positive for V. cholerae. Five strains were identified, all of which were negative for cholera enterotoxin (CT) when assayed in Y-1 categorical lines. No cholera cases were reported. tor cholera enterotoxin (C1) when assayed in Y-1 adrenal cell lines. No cholera cases were reported in the country. Two of the strains isolated were studied and determined to be hemolytic and resistant both to phage IV (specific for classical strain) and to phage specific for the eltor strain. They

were sensitive to polymixin B and negative by the Voges-Proskauer test, and presented a strong reaction with antiseral 0:1. However, they also reacted tion with antiseral 0:1. However, they also reacted with antiserum Inaba, so were not a typical eltor biovar. Pathogenicity was evaluated for CT in rabbit ileal loop, rabbits, and suckling mice, and by enzyme-linked immunoassay (ELISA) and radioimmunoassay. Results were, in general, negative. The isolation of nontoxigenic V. cholerae Olf from environmental samples is not rare. Many exfrom environmental samples is not rare. Many explanations have been proposed to explain this phenomenon, including mutations. The potential hazard of public health due to V. cholerae 0:1 may be contact occurs through use of sewage-contaminated water for crop irrigation or by other means. (See also W91-10612) (Doria-PTT) W91-10685

CLOSTRIDIUM PERFRINGENS, AS AN INDI-CATOR MICROORGANISM FOR THE EVAL-UATION OF THE EFFECT OF WASTEWATER AND SLUDGE TREATMENT SYSTEMS.

Azabu Univ., Sagamihara (Japan). Dept. of Environmental Technology. T. Hirata, K. Kawamura, S. Sonoki, K. Hirata. and

Water Science and Technology WSTED4, Vol. 24, No. 2, p 367-372, 1991. 3 fig, 2 tab, 23 ref. Ministry of Education, Science and Culture (Japan) Grant 62550402.

Descriptors: \*Bacterial analysis, \*Bioindicators, \*Clostridium, \*Disinfection, \*Monitoring, \*Path of pollutants, \*Sludge treatment, \*Wastewater treatment, \*Water quality, Bacteria, Chlorine, Feces, Heterotrophic bacteria, Hydrogen ion concentration, Lakes, Rivers.

A series of field investigations were performed to determine the incidence of several indicator microorganisms and Clostridium perfringens in order to evaluate the effectiveness and significance of C. perfringens as an indicator microorganism for fecal pollution. Water samples were collected from several stages of wastewater and sludge treatment eral stages of wastewater and sludge treatment processes and natural water bodies such as rivers and lakes. In addition, laboratory studies were performed to assess the chlorine resistance of these microorganisms. The contact time required for 99% inactivation of C. perfringens with 0.1 mg/L free chlorine at pH 7 was found to be 5 minutes for pure cultured cells; chlorine resistance of C. perfringens indigenous to sewage was 3 to 5 times higher. A proportional relationship was found behigher. A proportional relationship was found be-tween the density of C. perfringens and that of tween the density of C. perfringens and that of heterotrophic bacteria in environmental waters. Clostridium perfringens was least reduced in almost all unit processes, compared with the other indicator microorganisms studied. Results suggest that C. perfringens is an attractive indicator microganism for the assessment of microbial removal in wastewater and sludge treatment and for the evaluation of the quality of treated wastewater discharged to rivers or reused. As the quantity of this microorganism in human and animal feces is this microorganism in human and animal feces is relatively small, a concentration method must be developed to permit its use for the quantitative evaluation of microbial pollution. (See also W91-10612) (Author's abstract)

SALMONELLA DETECTION IN SEWAGE WATERS USING FLUORESCENT ANTI-WATERS BODIES.

Rennes-1 Univ. (France). Lab. de Microbiologie Pharmaceutique.

J. Minet, C. Desmonts, M. Pommepuy, and M.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 373-376, 1991. 4 fig. 5 ref.

Descriptors: \*Bacterial analysis, \*Chlorination, \*Disinfection, \*Fluorescence, identification, \*Salmonella, \*Wastewater analysis, Bacteria, Chlorine, Filtra-tion, Particulate matter, Wastewater, Water quality

Human pathogens persist in the aquatic environ-ment through a viable but nonculturable stage.

Chlorine injury might be lethal for only a small fraction of exposed cells, especially when bacteria are attached to suspended particulate matter. A direct detection procedure was therefore designed for Salmonella followup after chlorination of raw of the control of the contr effluent in an experimental sewage plant. Fluores cein isothiocyanate conjugated antirabbit immuncein isothiocyanate conjugated antirabbit immun-oglobulin was used for indirect fluorescent anti-body staining. Direct viable count (DVC) was modified as follows. Wastewater samples were fli-tered directly through black Nucleopore filters of pore size 3 microns for enumeration of Salmonella pore size 3 microns for enumeration of Salmonella attached to particulate matter; 0.2 microns for total Salmonella on whole sample and free Salmonella previously passed through 3 micron filters. In chlorinated wastewater, 5% to 31.5% of Salmonella were found to be substrate responsive in whole samples. The percentage of substrate responsive cells is <4% among free Salmonella. Six to 30 percent of Salmonella attached to particulate mater (retained on 3 micron filters) are substrate responsive. Direct detection of nathogens, rather, than (retained on 3 micron inters) are substrate responsive. Direct detection of pathogens, rather than reliance on culture methods, may more accurately assess water quality. Chlorination is inefficient for suppressing viability of Salmonella attached to particulate matter in wastewater. (See also W91-10612) (Doria-PTT) W91-10687

DESTRUCTION OF FAECAL BACTERIA, ENTEROVIRUSES AND OVA OF PARASITES IN WASTEWATER SLUDGE BY AEROBIC THERMOPHILIC AND ANAEROBIC MESOPHILIC DIGESTION,

Water Research Centre, Medmenham (England). E. G. Carrington, E. B. Pike, D. Auty, and R Morris.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 377-380, 1991. 2 tab, 16 ref. UK Dept of the Environment Contract PECD 7/7/261.

Descriptors: \*Disinfection, \*England, \*Enterovir-uses, \*Fecal bacteria, \*Microbiological studies, \*Parasites, \*Sludge digestion, \*Sludge treatment, \*Wastewater treatment, Bacteria, Coliforms, Eggs, Enteric bacteria, Fecal streptococci, Pathogens, Retention time, Sludge thickening, Survival, Tem-perature, Viruses, Volatile solids, Wastewater fa-

A new sludge treatment plant at Harrogate South Sewage Treatment Works (England) is designed to handle up to 4 tons dry solids (ds) daily. Sludge is thickened continuously up to 8% (ds) and is then treated in parallel anaerobic mesophilic (AD) and thermophilic aerobic digestion (TAD) plants, each with a maximum working volume of 530 cu m. Microbiological studies were carried out to compare the destruction of pathogase and facel indicated. Microbiological studies were carried out to com-pare the destruction of pathogens and fecal indica-tor bacteria. The AD plant operated with a mean retention of 26 days at 34 C and achieved 49% reduction of volatile solids. The TAD plant oper-ated with a mean retention of 28 days at 35 C and reduced volatile solids by 35%. Operation was on a pump in-pump out cycle, guaranteeing 4 h reten-tion time for all sludge. The disinfecting ability of TAD exceeded that of AD, since it reduced counts of Enterobacteriaceae, thermotolerant coliforms, and fecal streptococci to below 103/100 ml, rendered cytopathic enteroviruses undetectable, and destroyed viability of Ascaris suum ova within 4 h. The AD process reduced bacterial counts by 90% and enteroviruses by 99%, but had no effect upon viability of Ascaris ova. (See also W91-10612) (Author's abstract) W91-10688

CONTRIBUTION FOR THE STUDY OF NEW PATHOGENIC INDICATORS REMOVAL PATHOGENIC INDICATORS FROM W. S. P. IN PORTUGAL.

Direccao-Geral da Qualidade do Ambiente. Lisbon (Portugal).
M. J. Nascimento, J. S. Oliveira, L. Oliveira, and J.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 381-386, 1991. 4 fig, 3 tab, 6 ref.

Descriptors: \*Bacteria, \*Bioindicators, \*Microorganisms, \*Pathogens, \*Portugal, \*Stabilization ponds, \*Wastewater treatment, Climates, Clostridi-

### **Group 5D—Waste Treatment Processes**

um, Fecal coliforms, Fecal streptococci, Heterotrophic bacteria, Lagoons, Precipitation, Pseudomonas, Solar radiation, Temperature.

The use of waste stabilization ponds (WSP) is increasing in Portugal. The kinetics of pathogen removal by this nonchemical system differs according to the conditions of treatment and climatic cording to the conditions of treatment and climatic and ecological conditions. Die-off kinetics were studied in WSPs in Portugal using indicators other than the classic ones (fecal coliforms, fecal strepto-cocci, Clostridium perfringens, Pseudomonas aeruginosa, and heterotrophic bacteria). Removal kinetics were found to be different for each organism and in each type of pond. Multiple indicators should be used, as none of the indicators can be considered ideal. Specific climatic conditions are important for each organism and each type of reactor. The most important climatic influence on microbial die-off is precipitation; temperature, and solar radiation are also important. The influence of solar radiation are also important. The influence of climatic factors is stronger in anaerobic ponds than in facultative ponds, and least evident in maturation lagoons. A cumulative effect is very clear for the whole system. The dominant pattern for each climatic factor is different, being hyperbolic for daily precipitation influence and dominantly exponential for temperature and solar radiation (daily averages). These climatic influences, added to those from ecological sources, may help explain interannual and interregional differences observed among actual ponds. (See also W91-10612) (Doria-PTT)
W91-10689 W91-10689

DYNAMICS OF NON-01 VIBRIO CHOLERAE IN EXPERIMENTAL SEWAGE STABILIZATION PONDS UNDER ARID MEDITERRANE-AN CLIMATE.

AN CLIMATE.
Cadi Ayyad Univ., Marrakech (Morocco). Lab. de
Microbiologie.
J. Lesne, B. Baleux, A. Boussaid, and L. Hassani.
Water Science and Technology WSTED4, Vol.
24, No. 2, p 387-390, 1991. 3 fig, 1 tab, 14 ref.

Descriptors: \*Arid lands, \*Bacteria, \*Morocco, \*Stabilization ponds, \*Vibrio, \*Wastewater treat-ment, Bioindicators, Fecal coliforms, Fecal streptococci, Populations, Pseudomonas, Seasonal variation, Temperature. Radiation

The temporal dynamics of non-01 Vibrio cholerae and pollution indicator bacteria were studied in an experimental stabilization pond system consisting of two successive basins in an arid Mediterranean of two successive basins in an and Mediterranean climate (Marrakech, Morocco). The same seasonal cycle was found in the inflow, in the first pond, and in the outflow: low levels of V. cholerae during the cold season (December to March) and high level during the warm season (April to Nober). Temporal evolutions of non-01 V. cholerae are positively correlated with temperature throughout the treatment plant. This could indi-cate control of this bacterial population by climatic factors acting through physical, chemical, and bio-logical variables. However, temporal evolutions of non-01 V. cholerae are highly correlated with sev-eral environmental factors in the first basin only, and the relations are lost in the second basin. There and the relations are lost in the second usain. Their is no correlation with transmitted radiant energy throughout the treatment plant. In the ponds, temporal evolutions of non-01 V. cholerae are negatively correlated with fecal contamination indicatively correlated with fecal contamination indicators (fecal coliforms and fecal streptococi) and are not correlated with Pseudomonas aeruginosa. In the inflow, non-01 V. cholerae counts are correlated with P. aeruginosa and not with fecal contamination indicators. The treatment process is ineffective on the non-01 population: there is no bacterial reduction during the hot season, when other pollution indicators are well reduced, and there is no significant decrease during the cold season. (See also W91-10612) (Doria-PTT)

WASTE STABILIZATION PONDS IN GRAND CAYMAN, CAYMAN ISLANDS.
Water Authority, George Town (Cayman Islands).

G. L. Frederick.
Water Science and Technology WSTED4, Vol. 24, No. 2, p 391-394, 1991. 7 fig, 2 tab, 3 ref.

Descriptors: \*Cayman Islands, \*Odor control, \*Stabilization ponds, \*Wastewater treatment, Aerators, Anaerobic conditions, Biological oxygen demand, Color, Conductivity, Costs, Economic aspects, Fecal coliforms, Hydrogen sulfide, Salinity, Sulfates, Sulfides, Water table.

The Cayman Islands Water Authority selected waste stabilization ponds to treat the sewage from the West Bay Beach sewerage project because of the anticipated low operational and maintenance the anticipated low operational and maintenance cost. The two facultative ponds are operated in parallel, with the effluent of both going to the first maturation pond, and from there to a final maturation/polishing pond. High salinity in the incoming sewage poses a financial problem, since the final effluent cannot be sold for irrigation. Rising electrical conductivity was identified in the effluent since June 1988. Contributing factors include the flooding of sewers with seawater during Hurrigane. since June 1988. Contributing factors include the flooding of sewers with seawater during Hurricane Gilbert in September 1988; minor saline intrusion in sewers laid below the groundwater table; the use of seawater for toilet flushing; and septage disposal. Odor became a problem in October 1988. Sulfate levels have varied between 50 and 360 mg/L, and hydrogen sulfide has been detected in the final pond. However, performance measured by biologi-cal oxygen demand and fecal coliform removal do cal oxygen demand and react conform removal do not always coincide with high levels of sulfates and sulfides. Odor and color problems improved following the installation of 8 diffuse aerators in each of the two facultative ponds in October 1989. However, overall pond performance has not improved. Low levels of hydrogen sulfide are frequently found in the facultative pond, indicating that they are operating anaerobically from time to time. (See also W91-10612) (Doria-PTT) W91-10691

SURVIVAL OF PATHOGENIC BACTERIA IN AN ADVERSE ENVIRONMENT.

Technion - Israel Inst. of Tech., Haifa. Sherman Center for Research in Environmental and Water Resources Engineering. A. Barzily, and Y. Kott.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 395-400, 1991. 1 fig, 5 tab, 13 ref.

Descriptors: \*Enteric bacteria, \*Pathogenic bacteria, \*Stabilization ponds, \*Wastewater treatment, Bacteria, Effluents, Immunoassay, Salmonella, Shigella, Survival, Temperature, Temperature effects.

Pathogenic bacteria are known to be sensitive to changes in environmental conditions. This applies to Enterobacteriaceae as well, where optimum temperatures are 37 C. Wastewaters of various qualities are hostile environments to these bacteria. quanties are nostite environments to these bacteria. The influence of temperature was investigated on die-off of enteric bacteria in waste stabilization ponds within the temperature range of 40-60 C. Survival of indicator microorganisms at the control pond effluent was higher than at increased temperature pond effluent (40, 50, 60 C). Survival percentages of the indicators at the elevated temperature and compared to the option leaves percentages of the inducators at the elevated temperature pond compared to the control pond were 0.12% to 73.33%. Dialysis bags containing the pathogenic bacteria Salmonella typhimurium and Shigella sonnei were placed in the ponds. The numbers of the pathogenic bacteria decreased by a few orders of magnitude within days, depending on the temperature and on the strain. After certain periods of time, the bacteria held in the heated pond, and in some instances in the control pond, lost their ability to agglutinate with specific anti-bodies. This phenomenon requires further rebodies. This phenomenon requires further re-search; it might indicate an unknown heat survival mechanism of the pathogenic bacteria in adverse environments. (See also W91-10612) (Author's abstract) W91-10692

CONTROL OF ENTERIC MICRO-ORGANISMS BY AEROBIC-THERMOPHILIC CO-COM-POSTING OF WASTEWATER SLUDGE AND AGRO-INDUSTRY SLUDGE.

Hebrew Univ. of Jerusalem (Israel). For primary bibliographic entry see Field 5E. W91-10693

COMPARATIVE STUDY ON ADSORPTION MECHANISMS OF RNA-F-SPECIFIC COLI-PHAGES AND POLIOVIRUS IN ACTIVATED SLUDGE PROCESS.

Tokyo Univ. (Japan). Dept. of Urban Engineering. A. Ketratanakul, S. Ohgaki, and K. Yano. Water Science and Technology WSTED4, Vol. 24, No. 2, p 407-412, 1991. 7 fig, 10 ref.

Descriptors: \*Activated sludge process, \*Bacterio-phage, \*Indicators, \*Nucleic acids, \*Poliovirus, \*Viruses, \*Wastewater treatment, Acids, Adsorp-tion, Bases, Coliphages, Fate of pollutants, Glucose, Hydrogen ion concentration, Pathogens,

The adsorption mechanisms of RNA-F-specific coliphages, Q-beta, and poliovirus 1 in the activated sludge process was studied experimentally. The mechanisms of Q-beta and poliovirus associated with microbial flocs were attributable to the pH change in the system which was caused by either microbial activity during glucose uptake or the added acids and alkalis. When the pH of the activated sludge system was controlled by acids and alkalis rather than by microbial activity, the adauxains rather than by microma activity, the as-sorption of Q-beta or poliovirus was not observed unless the hydrogen ions went closely to Q-beta and poliovirus surfaces, resulting in a change in the pH or potential of the surface. If the pH was controlled closely to the isoelectric point (pls) of either Q-beta or poliovirus, the adsorbed numbers increased. The mechanisms of O-beta and poliovirus associated with microbial flocs were likely to rus associated with microbial nocs were likely to be similar, the only difference being the pI level of each. Therefore, given information on the pI value of a pathogenic virus, one could, in general, predict the fate of the particular virus in activated sludge based on coliphage Q-beta. Q-beta was found to be more tolerant to stress than poliovirus, since Q-beta remained stable for a week in a batch since Q-beta remained stable for a week in a batch reactor (activated sludge process). By contrast, poliovirus was reduced by about 0.8 log in three days in the same reactor. RNA-F-specific phage Q-beta proved to be a suitable model virus in wastewater, due to the similarity of association mechanisms with solids as well as high relative resistance to environmental conditions in the waste treatment process. (See also W91-10612) (Doria-

W91-10694

NEW DEVELOPMENTS IN PROCESSING OF SLUDGES AND SLURRIES.

Proceedings of a Round Table Seminar held April 22, 1985 in Bithoven, The Netherlands. Elsevier Science Publishing Co., New York. 1986. 89p. Edited by A.M. Bruce, P. L'Hermite, and P.J.

Descriptors: \*Farm wastes, \*Manure, \*Sludge di-gestion, \*Sludge disposal, \*Sludge treatment, \*Slurries, \*Wastewater treatment, Animal wastes, Conferences, Dewatering, Fuel, Reviews, Sludge, Sludge drying, Sludge stabilization, Sludge utilization, Solid waste disposal, The Netherlands.

This book contains the proceedings of a round-table meeting held at Bithoven, The Netherlands, in April 1985 under the auspices of the Commis-sion of the European Communities' Concerted Action on the treatment and use of organic sludges and liquid agricultural wastes. Working Party No. 1 of the Concerted Action has the task Party No. 1 of the Concerted Action has the task of coordinating nationally funded research on the processing of sewage sludges and animal slurries. New research developments in the field of sludge and slurry processing were reviewed and discussed. Three of the papers presented relate to sludge dewatering methods, two relate to methods of perchic stabilization of sludge and another paper. of aerobic stabilization of sludge and another paper describes a novel development in the conversion of sewage sludge to a usable fuel. The results of examining the influence of sludge processing tech-niques on some of the important organic micropol-lutants in sewage sludges are described in other contributions. The remaining paper deals with research on new ways of processing animal manures. (See W91-10700 thru W91-10707) (VerNooy-PTT) W91-10699

### Waste Treatment Processes—Group 5D

APPLICATION OF ELECTRICAL FIELDS TO THICKEN AND DEWATER SEWAGE SLUDGES.

Institut de Recherches Hydrologiques, Nancy (France).

IN: New Developments in Processing of Sludges and Slurries. Elsevier Science Publishing Co., New York. 1986. p 3-13. 24 ref.

Descriptors: \*Dewatering, \*Electric currents, \*Electrochemistry, \*Sludge drying, \*Sludge thickening, Consolidation sedimentation, Electrophoresis, Incineration, Particulate matter, Sludge, Sludge filters, Sludge treatment, Suspended solids.

Sewage sludges are made up of small solid parti-cles suspended in an aqueous solution. Application of an electric field can induce solid and liquid or an electric field can induce soind and inquid phases to move relative to each other. The pros-pects for applying electric fields for solid/liquid separation in urban sewage sludges are discussed. The electrochemistry of the interfaces and electro-kinetic effects are detailed, and basic laws of electrophoresis and of electro-osmosis are summarized. Applications of electric fields include: to speed up Applications of electric fields include: to speed up-sedimentation and gravity thickening of sludges; to concentrate sludges by filtering without any cake production; and to dewater liquid sludges until a solid residue is produced. Performance data and power consumption is listed for each of the experi-mental devices designed and tested. (See also W91-10699) (Author's abstract) W91-10700

INFLUENCE OF POLYELECTROLYTE CHARACTERISTICS ON SLUDGE CONDITIONING (LAB EVALUATIONS).

(LAB EVALUATIONS).
Istitute of Ricerca sulle Acque, Bari (Italy).
L. Spinosa, V. Lotito, F. Lore, and G. Barile.
IN: New Developments in Processing of Sludges and Slurries. Elsevier Science Publishing Co., New York. 1986. p 14-26. 4 fig, 4 tab, 13 ref.

Descriptors: \*Dewatering, \*Polyelectrolytes, \*Sludge conditioning, \*Sludge drying, \*Sludge treatment, Centrifugation, Chemical properties, Molecular structure, Sludge, Sludge filters, Sludge thickening, Weight.

In recent years polyelectrolytes have found in-creased utilization for sewage sludge conditioning before mechanical dewatering. Molecular weight and charge density are the most important polye-lectrolyte characteristics which affect their effec-tiveness. However, little information is found in the literature on which characteristics polyelectrolytes should have to obtain the most effective sludge conditioning for each dewatering technique studge conditioning for each dewatering technique adopted. Laboratory tests were carried out to study the influence of the above characteristics on sludge conditioning as a function of the type of dewatering machine. The filter press, belt press and centrifuge are the most utilized machines for and centringe are the most utilized macinnes for sewage sludge dewatering. Results showed that polyelectrolytes with low molecular weight and high charge density are preferable for conditioning sludge to be filter-pressed, with medium molecular weight and high charge density for sludge to be dewatered by belt press, and with medium molecular weight and medium charge density for sludge. dewatered by beit press, and with medium molecular weight and medium charge density for sludge to be centrifuged. These results allow a first rough selection among the different polyelectrolyte types available on the market to be done, thus limiting the number of tests for selecting the best type for a certain application. (See also W91-10699) (Author's abstract)
W91-10701

CHP-FILTER PRESS-THE FIRST CONTINU-OUS HIGH-PRESSURE FILTER PRESS.

Abwasser-Abfall-Aquatechnik, Darmstadt (Germany, F.R.).

In: New Developments in Processing of Sludges and Slurries. Elsevier Science Publishing Co., New York. 1986. p 27-35. 5 fig, 3 tab, 1 ref.

Descriptors: \*Dewatering, \*Sludge drying, \*Sludge filters, \*Sludge treatment, Dry matter, Mechanical equipment, Sludge, Sludge cake, Sludge solids, Sludge thickening.

In order to obtain satisfactory dewatering results in many cases of application, a considerable amount of equipment, and therefore high investment costs, of equipment, and therefore high investment costs, as well as a non-continuously working procedure, had to be accepted. To overcome these problems, the CHP-filter press, or continuous working high pressure filter press, was developed. Using this press, the pressure on a suspension to be dewatered can be continuously increased and therefore dewatering results which were only previously attainable using chamber, plate or membrane filter press can be obtained. The new continuous working high pressure filter press is built in six different types according to various applications. Based on the high and long lasting active pressures, the new press achieved final solid matter qualities in the filter cake under all applications tested so far. Since sewage sludge solid matter results ranged between 35 to 55% dry matter, the content of industrial suspensions were partly dewatered up to more suspensions were partly dewatered up to more than 75% dry matter continuously. (See also W91-10699) (VerNooy-PTT)

### DUTCH APPROACH TO MANURE PROCESS-

Government Agricultural Waste Water Service, Arnhem (Netherlands). P. J. W. ten Have.

In: New Developments in Processing of Sludges and Slurries. Elsevier Science Publishing Co., New York. 1986. p 36-46. 5 fig, 4 tab, 5 ref.

Descriptors: \*Animal wastes, \*Farm wastes, \*Fer-tilizers, \*Manure, \*Sludge disposal, \*Sludge treat-ment, \*Slurries, \*The Netherlands, \*Waste treat-ment, Aeration, Consolidation sedimentation, Dewatering, Pigs, Poultry, Sludge, Sludge condi-tioning, Sludge digestion, Sludge drying, Sludge

The last twenty years has shown a tremendous growth in the Dutch production of pig and poultry meat. This has been accompanied by an equivalent amount of animal excrements, which, until now, has been spread on agricultural land. Within a short time laws will be introduced which will allow maxima to be set on the amount of fertilizer applied to agricultural land. This will result in a sharp increase in the transport of animal slurries to farms with a shortage of minerals. Since there is only a small demand for veal calf manure most of it will have to be purified. Plans to do this have been developed at a central plant at Elspeet. After coarse screening the manure is transferred into a ocarse screening the manure is transferred into a balancing basin, and the daily volume of manure to be treated is pumped into the aeration basin. About 20 hours later aeration is stopped, and after 1 hour sedimentation the effluent is discharged to the sedimentation the effluent is discharged to the sewer system. Sludge is periodically used as fertilizer. For the longer term, it is expected that surpluses in pig manure will have to be treated as well. In the Sterksel experimental pig station process, undigested manure is conditioned with iron chloride and polyelectrolyte, and then separated and dewatered. The filtrate is purified in an activated sludge process and then the effluent is treated by reverse osmosis. For the Agricultural University of Wageningen process, the first step is anaerobic digestion of the complete flow. Next, is addition of lime, iron chloride and polyelectrolyte. After this, separation and dewatering is carried After this, separation and dewatering is carried out, with subsequent ammonia stripping and reout, with subsequent ammonia stripping and re-verse osmosis treatment. Large-scale processing of pig manure will really be possible only when there is no doubt about the disposal of the residual products, which means where, in what form, and for what price. (See also W91-10699) (VerNooy-PTT) W91-10703

AEROBIC THERMOPHILIC DIGESTION OF PRE-THICKENED SLUDGE USING AIR. B. Paulsrud, and G. Langeland. IN: New Developments in Processing of Sludges and Slurries. Elsevier Science Publishing Co., New York, 1986, Pd.93.8 4 66, At ab. 9 ref. York. 1986. p 49-58. 4 fig, 4 tab, 9 ref.

Descriptors: \*Aerobic digestion, \*Sludge digestion, \*Sludge thickening, \*Sludge treatment, \*Thermophilic bacteria, Aeration, Norway, Odors,

Operating costs, Pilot plants, Sieves, Sludge, Sludge conditioning, Sludge stabilization.

In 1983 the Danish company JANCA introduced In 1983 the Danish company JANCA introduced on the Norwegian market a new version of the aerobic, thermophilic digestion process using a special device (vibrating sieve) for thickening the raw sludge up to 8 to 10% before digestion. Pilot scale studies of (The JANCA-process) aerobic, thermophilic digestion of pre-thickened sludge using air were performed for seven weeks at the HIAS sewage treatment plant in Norway. By batch operation of the process with sludge draw and fill every second day, temperatures above 60 C could be maintained in the single stage reactor for approximately 30 hours. The treated sludge was satisfactorily santitized, but detention time was too short for rendering the sludge stable and odor free. The vibrating sieve did not function properly with the mixed primary-activated-chemical (A1) sludge and should therefore be replaced by another type of simple equipment that can produce a sludge of 8 to 10% dry solids (DS) (e.g., dewatering contain-e). The operating cost of the process (energy and polymer) is estimated to be about 150 NOK/ton DS, and the capital cost for a plant of 2,100 tons DS/year is about 2 million NOK (1984). (See also W91-10699) (Author's abstract) on the Norwegian market a new version of the W91-10704

## PROCESSING ORGANIC WASTE PRODUCTS TO BLACK SOIL AND ORGANIC FERTILIZ-

Rutte Recycling B.V., Amsterdam (Netherlands). For primary bibliographic entry see Field 5E. W91-10705

### SLUDGE MANAGEMENT BY THERMAL CONVERSION TO FUELS.

H. W. Campbell, and T. R. Bridle. IN: New Developments in Processing of Sludges and Slurries: Elsevier Science Publishing Co., New York. 1986. p 67-78. 3 fig. 2 tab, 9 ref.

Descriptors: \*Fuel, \*Heat treatment, \*Sludge treatment, \*Sludge utilization, \*Waste management, Canada, Dewatering, Fertilizers, Land application, Oil, Sludge, Sludge digestion, Sludge disposal, Sludge drying, Waste treatment, Wastewater

The philosophy of sludge management in the sewage treatment industry must respond to changes in processing costs and environmental requirements. As overall costs increase, the efficiency of sludge management must be increased by either upgrading the existing scheme or introducing new technology. Low temperature conversion of sludge to fuel appears to have considerable potential as a viable new technology. Experimental work carried out at Environment Canada's Wastewater Technology Centre used batch and continuous reactors to evaluate this technology at continuous reactors to evaluate this technology at bench-scale. Tests on a number of mixed raw sludges (primary plus waste activated) resulted in the following yield: oil, 22 to 25%; char, 50 to 60%; non-condensible gas, 10 to 12%; and reaction water 5 to 12%. The impact of a number of sludge treatment alternatives that are of concern include: application of digested sludge on agricultural land; digestion, dewatering and incineration of sludge; upgrading of sludge dewatering equipment to create an energy surplus upon sludge incineration; and conversion of sludge to oil. Factors such as energy efficiency, flexibility, and public acceptance of the method must also be considered. Environment Canada's long term plans are to demonstrate of the method must also be considered. Environ-ment Canada's long term plans are to demonstrate the technology for conversion of sludge to oil by construction of a 25 ton facility. The first phase of this demonstration study is currently underway with the development of the pre-engineering data, identification of suitable sites and a thorough as-sessment of the process economics. (See also W91-10699) (Author's abstract)

ACCUMULATION OF REFRACTORY 4-NON-YLPHENOL DURING MESOPHILIC ANAER-OBIC SLUDGE STABILIZATION,

### **Group 5D—Waste Treatment Processes**

Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Due-bendorf (Switzerland).

M. Tschui, P. H. Brunner, and W. Giger. IN: New Developments in Processing of Sludges and Slurries. Elsevier Science Publishing Co., New York. 1986. p 79-83. 4 fig, 6 ref.

Descriptors: \*Anaerobic digestion, \*Nonionic surfactants, \*Phenols, \*Sludge stabilization, \*Wastewater treatment, Biodegradation, Sludge, Sludge digestion, Sludge treatment.

4-Nonylphenol polyethoxylates are widely used nonionic surfactants which occur in municipal wastewaters. Anaerobically stabilized sewage sludges were found to contain high concentrations (0.45 to 2.5 g/kg dm) of toxic 4-nonylphenol. Two sets of experiments were performed: the anaerobic formation of 4-nonylphenol was examined in a continuous laboratory fermenter, and the anaerobic degradation of 4-nonylphenol was investigated by batch experiments. The experiments confirmed the formation of 4-nonylphenol by anaerobic mesophilic digestion of sewage sludge containing 4-nonyl-phenol monooxylates (NP1EO) and diethoxylates phenol monooxylates (NPIEO) and diethoxylates (NP2EO). When the fermenter was operated at a residence time of 20 days, approximately 60% of NPIEO and NP2EO were degraded and NP increased by a factor of 2. It was not possible to determine if nonylphenol was strictly refractory under anaerobic conditions by the batch experi-ments which were performed. Therefore, the models used assumed no further degradation of 4-nonlyphenol in the continuous fermenter. Preliminonyipation in the Collimanous Fernitude: Ferning arry results of a field investigation into the fate of 4-nonylphenol polyethoxylates during aerobic and anaerobic mesophilic and thermophilic stabilization indicate that the degradation products formed by the processes are significantly different. (See also W91-10699) (VerNooy-PTT)

### ENVIRONMENTAL FEASIBILITY OF USING WETLANDS TO TREAT RUNOFF POLLU-TION.

Naval Ocean Systems Center, San Diego, CA. L. E. Gadbois.

Available from the National Technical Information Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A215 040. Price codes: A03 in paper copy, A01 in microfiche. Technical Report 1321, October 1989. 31p, 2 tab, 25 ref. 2 append.

Descriptors: \*Environmental impact, \*Wastewater treatment, \*Wetlands, \*Wetlands treatment, Biochemical oxygen demand, Ecological effects, Heavy metals, Military installations, Nonpoint pollution sources, Nutrients, Organic compounds, Runoff.

Chemical and ecological characteristics of wetland types commonly occurring in and around Navy bases are reviewed. The natural wetland processes oases are reviewd. The initial weunal processors are examined from the perspective of their capac-ity to remediate nonpoint source pollution (NPSP). The ecological habitat value of wetlands is iterat-ed, as are the habitat value changes resulting from ed, as are the manula value changes resulting from pollution loading. Wetlands can assimilate small loading rates of nutrients, biochemical oxygen demand (BOD), suspended solids, bacteria and degradable petroleum components, and provide valuable ecological habitat. Heavier loadings will damage the marsh, reduce its habitat value, and exceed the assimilative capacity. Nondegradable contaminants (heavy metals, some organics) may be contained in the marsh. Over the short-term, be contained in the marsh. Over the short-tern, this will ease the chronic exposure impact to adjacent recipient water, but over the long-term a toxic waste dump may develop. The morphology of the marsh has a major impact on the remediation effectiveness. Flushing, which sustains the marsh, also removes some pollutants before ample time for degradation has occurred. There is a large knowledge gan to bridge before the exological impact of edge gap to bridge before the ecological edge gap to bridge before the ecological impact of a chemically characterized effluent added to a marsh can be confidently predicted. Wetlands may be the best available technique for some runoff situations and be disastrous for others. Careful research will clarify those cases for which this technique is and is not appropriate. Wetlands will not be a universally applicable method for runoff

remediation, but they should be the technique of choice for some situations. (Lantz-PTT) W91-10737

#### ROLE OF BIOTECHNOLOGY IN THE TREAT-MENT OF SLUDGES. GEOTHERMAL RESIDUAL

Brookhaven National Lab., Upton, NY. Dept. of Applied Science.
E. T. Premuzic, and M. S. Lin.

E. 1. Premuzic, and M. S. Lin. Available from the National Technical Information Service, Springfield, VA. 22161, as DE89-017609. Price codes: A02 in paper copy, A01 in microfiche. Report No. BNL-42361, May 1988. 4p. 5 fig, 8 ref. DOE Contract No. DE-AC02-76CH00016.

Descriptors: \*Biotechnology, \*Geothermal wastes, \*Sludge treatment, \*Waste disposal, \*Waste treatment, \*Wastewater treatment, Biofilm reactors, Brines, Chemical precipitation, Chromium, Electric powerplants, Geothermal water, Metals, Toxic

Powerplants which use geothermal heat to generate electric power produce a residual sludge in large quantities. This material precipitates from supersaturated brines and contains toxic metals, some of which are present in concentrations exsome of which are present in concentrations ex-ceeding the non-hazardous waste disposal regula-tions. Disposal of this waste as hazardous waste is costly. Work in this laboratory has shown that a biotreatment of the geothermal waste in which toxic metal resistant acidophilic organisms are used, can serve as a basis for a new biotechnology for the detayification of geothermal residual brine for the detoxification of geothermal residual brine sludges. Phase one studies have shown that an economically and technically feasible biotechnology can be developed. The efficiency of this technology depends on a number of parameters such as the bioreactor design residence the the bioreactor design, residence time, and the number and concentration of toxic metals to be removed. Further, the process, while rendering a detoxified material, produces a liquid phase which is enriched in toxic metals. This aqueous phase can be reinjected into the wells, or processed for the recovery of toxic metals, some of which are commercially valuable; for example, chromium. A par-allel study in this laboratory has shown that a combined chemical and biochemical process for the recovery of these metals may also be feasible. (Author's abstract) W91-10744

# AEROMONAS SPECIES STABILIZATION PONDS IN THE ARID REGION OF MARRA-KESH, MOROCCO, AND RELATION TO FECAL-POLLUTION AND CLIMATIC FAC-

Cadi Ayyad Univ., Marrakech (Morocco). Lab. de Microbiologie. A. Boussaid, B. Baleux, L. Hassani, and J. Lesne. Microbial Ecology MCBEBU, Vol. 21, No. 1, p 11-20, 1991. 5 fig, 2 tab, 30 ref.

Descriptors: \*Aeromonas, \*Bacterial analysis, \*Fecal coliforms, \*Morocco, \*Wastewater pollution, \*Wastewater treatment, Irrigation water, Pathogenic bacteria, Seasonal distribution, Species composition, Statistical analysis, Wastewater facilities, Water reuse, Water temperature.

Water samples were collected in two-week inter-Water samples were collected in two-week inter-vals from July 12, 1985 to December 23, 1987, for estimates of Aeromonas species in a waste treat-ment system located in the arid region of Marra-kesh. Fecal coliforms, temperature, and chemical oxygen demand were measured simultaneously with Aeromonas species densities. Statistical meth-ods were used to analyze the significance of aver-age differences and temporal patterns of Aero-monas species numbers. Removal of Aeromonas in the whole system did not exceed 1.14 log. Aero-monas densities showed significantly higher resismonas densities showed significantly higher resistance to the treatment process when compared with fecal coliforms; however, abundance of the two groups presented a similar seasonal change. The highest numbers occurred during the cold months, while the lowest appeared in the warm months. Statistical time-series analysis of the densities data showed the seasonal and cyclic distribution of Aeromonas in this treatment plant. These temporal

changes were simultaneously observed in all the changes were simulated by observed in all the stations investigated and were negatively correlated with temperature values. Aeromonas populations were dominated by A. caviae and A. hydrophila in the inlet samples. These two species were rapidly eliminated in the treatment plant. The temporal distribution of A. caviae was similar to the densities of Aeromanas and fecal coliforms. Seasonal fluctuations of abundance of Aeromonas were probably related to this species, which dominate the color of the nated in the winter samples but dropped during the summer. Meanwhile, A. sobria dominated all the final effluent samples. This greater survival of A. sobria and its known pathogenicity may limit the re-use of treated water for irrigation of fodder plants. (Author's abstract)

## COMPARISON OF PRESSURIZED AND GRAVITY DISTRIBUTION SYSTEMS FOR WASTEWATER TREATMENT.

Arkansas Univ., Little Rock, Dept. of Electronics and Instrumentatio

M. Gross, S. Neal, R. Muldoon, and B.

Proceedings of the Arkansas Academy of Science AKASAO, Vol. 44, p 53-55, 1990. 5 fig, 12 ref.

Descriptors: \*Biochemical oxygen demand, \*Filtration, \*Gravity filters, \*Pressure filtration, \*Wastewater facilities, \*Wastewater treatment, Ammonia removal, Nitrification, Nitrogen removal, Organic pollutants, Suspended solids.

Pressurized distribution of domestic wastewater over a sand filter surface achieves better treatment than gravity distribution. The pressurized distribu-tion system caused the filter to better remove organics and suspended solids. Pressurized distri-bution also caused the sand filter to achieve more complete nitrification than the filter having gravity complete intrincation that in the inter naving gravity distribution. Two slow sand filters 15.2 cm wide, 3.1 m long and 15.2 cm deep were built and loaded with domestic septic tank effluent for 250 days at a rate of 5.1 cm/day. Influent and effluent samples were collected and analyzed for five-day Bio-chemical Oxygen Demand (BOD-5), suspended chemical Oxygen Demand (BOD-5), suspended solids, ammonia-nitrogen, and nitrate-nitrogen. One filter received septic tank effluent through a 10 cm nominal diameter PVC perforated pipe via a distribution box dosed by a pump with gravity flow from the distribution box to the pipe. The other filter received water through a 2.5 cm nominal diameter PVC pipe having 0.4 cm diameter holes drilled 76.2 cm on center. The gravity distribution filter system achieved mean effluent values of 36.4 mg/l BOD-5, 19.8 mg/l suspended solids, 37.6 mg/l ammonia nitrogen, and 46.6 mg/l nitrate-nitrogen. The pressurized distribution system achieved 19.1 mg/l BOD-5, 12.2 mg/l suspended solids, 25.3 mg/l ammonia nitrogen, and 64.03 mg/l nitrate-nitrogen. Influent to the filters averaged 132.1 mg/l, 90.3 mg/l, 70.3 mg/l, and 3.6 mg/l BOD-5 suspended solids, ammonia nitrogen, and nitrate-nitrogen, respectively. (Author's abstract) W91-10845

### FATE AND EFFECTS OF SEMIVOLATILE OR-GANIC POLLUTANTS DURING ANAEROBIC DIGESTION OF SLUDGE.

Cincinnati Univ., OH. Dept. of Chemical Engi-

R. Govind, P. A. Flaherty, and R. A. Dobbs. Water Research WATRAG, Vol. 25, No. 5, p 547-556, May 1991. 7 fig. 7 tab, 21 ref. EPA Coopera-tive Agreement No. CR812939-01.

Descriptors: \*Anaerobic digestion, \*Biological wastewater treatment, \*Fate of pollutants, \*Organic pollutants, \*Sludge digestion, \*Volatile organic compounds, \*Wastewater treatment, Interference, Primary wastewater treatment, Retention time, Secondary wastewater treatment, Sorption, Secondary wastew Wastewater analysis. Sorption, wastewater treatment,

Anaerobic digestion of primary and secondary sludge containing selected semivolatile organic pollutants was investigated. Typical digester operation was simulated with three, complete-mix, bench-scale digesters maintained at 35.5 C with a

### Waste Treatment Processes—Group 5D

30 day solids retention time. Two digesters were fed a primary and secondary sludge mixture pro-duced from wastewater spiked with 20 semivolatile organics from the CERCLA pollutant list. The remaining digester (the control) was fed a similar mixture of sludge, but with no added organics. mixture of sludge, but with no added organics. Operational parameters were monitored to compare the test and control units. All parameters were found to be within the limits of normal operation. Performance was near identical. An isotope dilution GC/MS method was employed for organics analysis of influent and effluent streams for all reactors. Steady-state fates of the organics were determined by mass balance. Twelve of the chemicals appear consistently and at steady state. Degradation was apparent for all components, with at least 10% of each parent compound partially or completely transformed. Sorption onto digester solids was an important removal mechanism. Results of organic analysis for the control digester highlight the effects of metabolic interferences. (Author's abstract) (Author's abstract) W91-10884

REMOVAL OF ACETATE FROM NSSC SUL-PHITE PULP MILL CONDENSATES USING THERMOPHILIC BACTERIA.

Valtion Teknillinen Tutkimuskeskus, Espoo (Fin-

land). Biotekniikan Lab. M. Perttula, M. Konradsdottir, J. Pere, J. K.

M. Feltuns, M. Kolliadsoutin, J. Fele, J. K. Kristjanson, and L. Viikari. Water Research WATRAG, Vol. 25, No. 5, p 599-604, May 1991. 4 fig. 4 tab, 19 ref. Nordisk Indus-trifond grant No. P 86013.

Descriptors: \*Acetates, \*Biological wastewater treatment, \*Pulp wastes, \*Sulfite liquors, \*Thermophilic bacteria, \*Wastewater treatment, Aerobic bacteria, Ammonia, Diatomaceous earth, Energy use efficiency, Industrial wastewater, Packed beds.

Treatment of sulfite mill condensates containing acetate and ammonia was studied using aerobic thermophilic bacteria at 65 C. A separate treatment at this relatively high temperature could save at this relatively high temperature of the renergy and decrease water consumption in the process. Experiments were carried out in packed bed bioreactors (vol. 0.1-0.3 cu dm) using media based either on condensate or on ammonium acebed intreactors (vol. 0.1-0.2 of um) using media based either on condensate or on ammonium ace-tate. Diatomaceous earth was superior to the other carrier materials tested (red brick, activated carbon, pumice). At 90% acetate removal, the carron, punitice). At 30% accutate removal, the acctate consumption rates were about 0.7 and 0.5 g/cu dm/h on ammonium acetate (acetate 5 g/cu dm) and dilute condensate media (acetate 2 g/cu dm), respectively. The corresponding dilution rates were 0.15 and 0.38/h. (Author's abstract)

USE OF BACILLUS THURINGIENSIS VAR. IS-RAELENSIS TO CONTROL THE NUISANCE FLY SYLVICOLA FENESTRALIS (ANISOPO-DIDAE) IN SEWAGE FILTER BEDS. Salford Univ. (England). Dept. of Biological Sci-

ences. R. M. Coombs, B. N. Dancer, D. H. Davies, J. Houston, and M. A. Learner. Water Research WATRAG, Vol. 25, No. 5, p 605-611, May 1991. 5 fig, 6 tab, 13 ref.

Descriptors: \*Bacillus, \*Biocontrol, \*Flies, \*Insect control, \*Microbial insecticides, \*Wastewater fa-cilities, England, Environmental effects, Filters, Life cycles, Public nuisance, Receiving waters.

The effectiveness of using the microbial insecticide Bacillus thuringiensis var. israelensis (Bti) to control the nuisance fly Sylvicola fenestralis at Rossendale Sewage Works, Lancashire, England, was investigated. Following a provisional trial in 1987, the whole Works (28 filter beds) was treated with a two-stage application of Bti in 1988; the first application in late April was separated from the second in late May by about half the length of the Sylvicola life-cycle. The Bti treatment was timed to reduce fly nuisance in June, the month when most complaints (71%) had been received. For each application, 0.16 L of the Bti preparation, containing nearly 10 billion spores/cu cm, was applied per The effectiveness of using the microbial insecticide ing nearly 10 billion spores/cu cm, was applied per square meter of bed surface. An 80 and 98% kill of Sylvicola larvae was recorded following the first

and second applications, respectively. The lower kill achieved by the first application was believed to be due to insufficient mixing of the Bit with the settled sewage prior to dosing. Nuisance caused by the flies was considerably reduced; there were no complaints from the public during June, although a few were received in late July and early August. Sewage purification efficiency was not affeted by Bti treatment. The maximum concentration of Bti spores in the Works' effluent was 70,000 spores/cu cm. This concentration did not appear to affect the already impoverished macroinvertebrate fauna of the receiving river. (Author's abstract)

DYNAMIC SIMULATION OF STORM TANKS. Laval Univ., Quebec. Dept. of Civil Engineering. P. Lessard, and M. B. Beck.

Water Research WATRAG, Vol. 25, No. 4, p 375-391, April 1991. 13 fig, 3 tab, 38 ref.

Descriptors: \*Combined sewer overflows, \*Model studies, \*Retention tanks, \*Simulation analysis, \*Storm-overflow sewers, \*Urban runoff, \*Water pollution control, Ammonium, Nitrogen, Precipitation, Sedimentation, Storms, Suspended solids.

Storm retention tanks are used widely for regulating pollution caused by combined sewer overflows, a notably transient, dynamic phenomenon. Nevertheless, few dynamic models of the process have hitherto been proposed. A conceptual model for simulation of the dynamic performance of a storm tank is presented. Four modes of behavior are identified: fill, draw, dynamic sedimentation and quiescent settling. Discussion is given of the problems associated with the model, in particular the characterization of spatial non-uniformities in pollutant concentrations. Simulation results are resented for the application of the model to a test storm disturbance based on field data taken from the Norwich Sewage Works in eastern England. The disturbance comprises the response of a sewer The disturbance comprises the response of a sewer network to a high-intensity, short-duration precipi-tation event, with a significant transient increase in suspended solids concentration and a transient de-pression in ammonium-N concentration. The impact of the storm tank returns on primary clarifi-er performance is found to be almost negligible. uthor's abstract) W91-10928

INFLUENCE OF REACTOR MIXING CHARACTERISTICS ON THE RATE OF NITRIFICATION IN THE ACTIVATED SLUDGE PROC-

Leeds Univ. (England). Dept. of Civil Engineer-

A. A. Azimi, and N. J. Horan. Water Research WATRAG, Vol. 25, No. 4, p 419-423, April 1991. 6 fig, 2 tab, 19 ref.

Descriptors: \*Activated sludge process, \*Mixing, \*Nitrification, \*Plug flow, \*Wastewater reactors, \*Wastewater treatment, Ammonia, Bulking sludge, Inhibition, Kinetics, Nitrogen fixing bacteria, Sedi-

The effect of longitudinal mixing on nitrification was evaluated in two bench scale activated sludge was evaluated in two bench scale activated sludge reactors of equal volume, one approximating com-plete mixing, and one approximating plug-flow mixing. The onset of nitrification was more rapid under plugflow conditions and a higher rate con-stant for nitrification wa observed. Both the num-bers and species of nitrifying bacteria were the same in both reactors and thus did not contribute to the observed differences. Lower reaction rates in the complete mix reactor were shown to result in the conserved anterences. Lower reaction rates in the complete mix reactor were shown to result from high concentration of free ammonia in the mixed liquor, which gave rise to inhibition of nitrifying bacteria. Over an extended operating period, the plug-flow reactor produced a sludge which demonstrated superior settling properties to that of the complete mix reactor. In addition incidences of shudge hulting were about whereas they were a sludge bulking were absent, whereas they were a regular feature of he complete mix system. (Auor's abstract) W91-10932

COMPARATIVE STUDY AND MATHEMATI-CAL MODELING OF TEMPERATURE, LIGHT AND GROWTH OF THREE MICROALGAE POTENTIALLY USEFUL FOR WASTEWATER

Laval Univ., Quebec. Groupe de Recherche en Recyclage Biologique et Aquiculture. P. Talbot, J. M. Thebault, A. Dauta, and J. de La

Water Research WATRAG, Vol. 25, No. 4, p 465-472, April 1991. 4 fig, 2 tab, 35 ref.

Descriptors: \*Algae, \*Growth, \*Light effects, \*Model studies, \*Temperature, \*Wastewater treatment, Biological wastewater treatment, Comparison studies, Culturing techniques, Kinetics, Mathematical studies, Wastewater management.

Since it is difficult to study potential new microal-gal candidates under all conditions of light and temperature, mathematical modeling of these variables provides a useful tool for growth prediction and characterization. Using growth rate data obtained for light intensities from 3 to 650 microE/sq-m s, and for temperatures from 5 to 35 C, the effects of these two variables on the growth of Ankistrodesmus falcatus, Phormidium bohneri and Oscillatoria agardhii have been compared and mathematically formulated. At temperatures of 20 C or less, A. falcatus showed the best growth; no significant difference existed between P. bohneri and A. falcatus at 25 C. At 30 and 35 C, P. bohneri tetter withstood high light intensities. The effect and A. falcatus at 25 C. At 20 and 35 C. P. bonnen better withstood high light intensities. The effect of light intensity on growth at the various tempera-tures tested was modeled simultaneously to express growth as a first step towards a model for the management and optimization of intensive algal cultures for the biotreatment of wastewaters. (Au-thor's abtract) thor's abstract)

ANAEROBIC TREATABILITY OF A PHENO-LIC COAL CONVERSION WASTEWATER AFTER DIISOPROPYL ETHER EXTRACTION. Alberta Univ., Edmonton, Dept. of Civil Engi-

W. B. Kindzierski, P. M. Fedorak, and S. E. Hrudey.

Water Research WATRAG, Vol. 25, No. 4, p 479-484, April 1991. 4 fig, 3 tab, 26 ref.

Descriptors: \*Anaerobic conditions, \*Ethers, \*Industrial wastewater, \*Phenolics, \*Pretreatment of wastewater, \*Wastewater treatment, Activated carbon, Biodegradation, Industrial wastes, Inhibition, Phenols, Separation techniques.

The combined treatment requirements for a high strength phenolic wastewater were examined in semicontinuous methogenic cultures. Selective pH adjustment of H-coal wastewater followed by disopropyl ether extraction was used to control the phenolic concentration fed to the serum bottle cultures. This pretrainment did not comprisely. phenolic concentration fed to the serum bottle cultures. This pretreatment did not completely remove the unidentified inhibitory compound(s) from the wastewater. Thus the addition of activated carbon to the cultures and a reduced feed rate were required to stabilize their activity. However, by the end of the 250-day test period, the cultures were maintained with a 12.5-day hydraulic retention time and were fed approximately 9 parts pH 9-extracted H-coal wastewater and 1 part inorganic nutrient solution. The influent phenol concentration was near 900 mg/L, whereas the effluent concentration was c 2 mg/L. Residual dissolved diisopropyl ether did not inhibit the anaerobic process nor was it biodegraded to methane. (Author's abstract) thor's abstract) W91-10939

EVAPORATIVE DRYING OF DREDGED MA-TERIAL.

Hole, Montes and Associates, Inc., Naples, FL. R. E. Benson, and B. L. Sill.

Journal of Waterway, Port, Coastal and Ocean Engineering (ASCE) JWPED5, Vol. 117, No. 3, p 216-234, May/June 1991. 10 fig, 5 tab, 9 ref, 5

### **Group 5D—Waste Treatment Processes**

Descriptors: \*Dredging wastes, \*Forced drying, \*Solid waste disposal, \*Spoil disposal, \*Waste management, \*Waste treatment, Evaporation, Evaporation rate, Moisture index.

Material that is dredged from U.S. harbors and rivers must be disposed of in an environmentally acceptable manner. Dredged material disposed in confinement-type disposal areas undergoes volume reduction through the processes of sedimentation, self-weight consolidation, and evaporative drying. An approximate, closed-form solution to the equation governing the evaporative drying of dredged material has been developed. This solution includes both the constant-rate and the falling-rate drying periods. Different solutions are obtained for two basic geometric cases of 'semi-infinite' and 'thin' material layers, and the analysis provides a definition to differentiate these two cases. The solutions were compared with laboratory drying tests of actual dredge spoil from Charleston Harbor, South Carolina, and show good agreement. Finally, the solutions were compared with drying tests of other researchers for material from Toledo (Ohio), Mobile (Alabama), Philadelphia (Pennsylvania), and Norfolk (Virginia). It was found that the drying of dredged material layers is at a rate much less than the evaporation potential. Freshwater materials have ligher values for moisture diffusivity than saltwater materials, and fine-grained materials have lower values for moisture diffusivity than saltwater materials, and fine-grained materials have lower values for moisture diffusivity than saltwater materials. The closed-form solution performed better in all cases than the use of pan evaporation to predict drying rates. This approach has advantages in that the degree of drying can be computed directly, without having to rely on a numerical solution (beginning at time zero) to obtain intermediate values of drying. (Fish-PTT) W91-11000

EVALUATION OF FULL SCALE ACTIVATED SLUDGE SYSTEMS UTILIZING POWDERED ACTIVATED CARBON ADDITION WITH WET AIR REGENERATION.

ACTIVATED CARBON ADDITION WITH WET AIR RECENERATION.
Weston Services, Inc., West Chester, PA.
K. J. Deeny, J. A. Heidman, and A. J. Condren.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-112624.
Price codes: A03 in paper copy, A01 in microfiche.
Report No. EPA/600/D-89/124, 1989. 27p, 5 fig, 9 tab. 29 ref.

Descriptors: \*Activated sludge process, \*Powdered activated carbon, \*Regeneration, Activated carbon, Ash, Carbon, Costs, Design standards, Pollutant load, Sludge solids, Wastewater facilities.

The addition of powdered activated carbon (PAC) to activated sludge systems is a proven method of wastewater treatment. Of eleven publicly owned treatment works (POTWs) in the United States that were designed for PAC use, ten included wet air regeneration (WAR) for the destruction of secondary sludge solids and recovery of spent PAC. The eleventh plant was designed for PAC use on a single pass basis as have essentially all of the industrial facilities using this technology. Follow-ups at these facilities using this technology. Follow-ups at these facilities indicated the recurrence of certain performance and operation and maintenance (O and M) problems. As a consequence, US EPA collections and evaluations were continued through mid-1988. As part of this evaluation, all 11 POTWs were contacted to obtain basic design, O and M and performance data. The technology factors that were evaluated included effluent quality, ash buildup, carbon losses, carbon analytical methodology, wet air regeneration, recycle loadings, operational/design modifications and costs. Assumptions that PAC losses through WAR are 5% or less are based on the selected use of the nitric acid digestion technique. The measured losses reported in this study average 30% to 40% per cycle, but this is only a qualitative estimate. Ash accumulated in all PAC/WAR systems which relied on WAR blowdown for removal of a concentrated ash stream. All facilities have or are in the process of modifying the design and/or operation of their facilities to limit ash buildup. Loadings attributed to the WAR return stream are significant in terms of BOD and NH3-N. Total

phosphorus can also be quite high especially where mineral addition is used for phosphorus removal. Average 1986 O and M costs for three facilities were \$21.86, \$27.68 and \$42.00 per 1,000 gallons processed through the WAR reactor. (Lantz-PTT) W91-11099

SEWAGE SLUDGE TREATMENT AND USE: NEW DEVELOPMENTS, TECHNOLOGICAL ASPECTS AND ENVIRONMENTAL EFFECTS. For primary bibliographic entry see Field 5E. W91-11115

PRODUCTION, TREATMENT AND HANDLING OF SEWAGE SLUDGE.

Water Research Centre, Medmenham (England). P. J. Newman, A. V. Bowden, and A. M. Bruce. IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 11-38. 16 fig, 8 tab, 2 append.

Descriptors: \*Biological treatment, \*Europe, \*Land disposal, \*Sludge disposal, \*Sludge drying, \*Sludge treatment, \*Waste disposal, \*Wastewater treatment, Aerobic digestion, Agriculture, Comparison studies, Forestry, Horticulture, Land reclamation, Recycling, Regulations.

A survey of sewage sludge treatment and disposal practices in the Member States of the European Community (EC) has been undertaken by the UK Water Research Centre between October 1985 and August 1986. The data were collected through the use of a questionnaire and the assistance of representatives from each Member State who were identified through the COST 681 program on the Treatment and Use of Organic Sludges and Agricultural Wastes. The questionnaire returns show that in 1984, 5,564,000 tons of sludge (as dry solids) were disposed of from over 32,000 sewage treatment works in the EC, excluding Portugal (for which no data are as yet available). Thirty-seven percent was recycled to land, including agriculture, land reclamation, horticulture, forestry, and parkland; 44% disposed of to landfill sites; 9% incinerated; 7% disposed of to a number of minor outlets including sacrificial land, sludge farms and processed products. Seventy-nine percent of the sludge was treated prior to disposal with the main treatments being mesophilic anaerobic digestion and cold aerobic digestion, and 71% of the sludge was dewatered, mainly by plate-pressing, belipressing, dewatering by centrifugation, and airdrying on beds. All countries forese increases in their rate of sludge production in the next ten years, with the EC's total sludge disposal in 1994 predicted to be 33% higher than that in 1984. (See also W91-11115) (Author's abstract)

PHYSICAL AND CHEMICAL CHARACTER-IZATION OF SEWAGE SLUDGE.

Institut de Recherches Hydrologiques, Nancy (France).

F. Colin, R. Leschber, and G. Mininni.

In: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 40-52. 3 fig. 1 tab. 34 ref.

Descriptors: \*Landfills, \*Sludge, \*Sludge disposal, \*Sludge treatment, \*Waste disposal, \*Wastewater treatment, Biological properties, Chemical properties, Digested sludge, Heavy metals, Physical properties, Sampling, Sludge drying, Sludge thickening, Total solids.

Sewage sludges exhibit wide variations in their physical, chemical and biological properties according to their origin, type, previous treatment and period of storage. Sampling can be considered the first step in sludge characterization. Various parameters important in sludge characterization include gravity thickening, digestibility, dewaterability, and thermal properties. Methods for determining total solids residue (dry matter) and for digestion with concentrated acids as a prerequisite for the analysis of heavy metals are available. Dewa-

tered sludge water content is not sufficient to forecast mechanical properties of the material which determine the choice of the handling devices and the behavior of the waste in a landfill. (See also W91-11115) (Brunone-PTT) W91-11115

SLUDGE REDUCTION POSSIBILITIES AS DEMONSTRATED BY THE CHEMOLYSIS PROCESS DOW STADE GMBH.

Wasserwirtschaft Stade (Germany, F.R.). H. Reincke.

H. Reincae.

IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 53-57. l fig.

Descriptors: \*Chemical treatment, \*Sludge, \*Sludge drying, \*Sludge treatment, \*Wastewater treatment, Hydrochloric acid, Hydrogen ion concentration, Residence time, Sludge filters, Sludge thickening, Steam. Thermal properties.

The Chemical Concern Dow Stade GmbH reduces excess biox sludge using the chemolysis process, which results in a reduction of greater than 80% of total sludge volume and also reduces the amount of water in the remaining filter cake (thereby improving its disposal characteristics). In October 1988, a large test plant with 200 cubic m/day of sludge from Stade City treatment plant was operated for a time period of approximately one week. In the chemolysis operation, the excess sludge is pretreated with a 10% solution of hydrochloric acid and then thickened in a concentrator. After an additional dosing of hydrochloric acid and steam to bring about the correct pH and temperature, the sludge is fed into the pipe loop reactor with a residence time of about two hours. The settled sludge is dehydrated to a 50% dry substance state in a filter press and sent to an external disposal site. Based on test runs using municipal sludge and a two-year operation of a full-sized plant, the process is suitable for the community as well as in industry for fundamental alleviation of pressing waste disposal problems. (See also W91-11115) (Brunone-PTT)

ODOUR PROBLEMS WITH SEWAGE SLUDGE.

Instituut voor Mechanisatie, Arbeid en Gebouwen, Wageningen (Netherlands).

J. H. Voorburg, and J. J. van den Berg. IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 102-115. 5 fig, 1 tab, 16 ref.

Descriptors: \*Hydrogen sulfide, \*Odor control, \*Odors, \*Sludge, \*Sludge treatment, \*The Netherlands, \*Wastewater treatment, Air pollution, Biofilters, Biological treatment, Chemical properties, Emission control, Regulations.

In the framework of the COST 681 programme, the desirability of harmonizing olfactoric measurement of odors from manure and sewage sludge has resulted in recommendations on this type of measurement. In the Netherlands, a preliminary limit for odor nuisance is expressed in odor units. However, in practice, odor emission from sewage plants is expressed in kilograms of hydrogen sulfide or ammonium. Although the calculation of odor concentrations from concentrations from concentrations of hydrogen sulfide emission reduces the number of complaints of odor nuisance. The application of chemical or olfactoric odor measurement, therefore, demands further consideration. The most effective control of hydrogen sulfide emissions from sewage plants is treatment of the air in a biofilter. Practical experience has shown that this control results in considerable odor reduction though few measurements are available to confirm this hypothesis. (See also W91-11115) (Author's abstract)

### Waste Treatment Processes—Group 5D

MODERN SLUDGE MANAGEMENT: THE MANAGER'S CHOICE.

MANAGER'S CHOICE.

European Water Pollution Control Association,
Markt 1, D-5205, Sankt Augustin,,G Germany.
P. J. Matthews, and W. Schenkel.
IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co.,
New York. 1989. p 116-128. 2 tab, 22 ref.

Descriptors: \*Europe, \*Sludge disposal, \*Sludge treatment, \*Sludge utilization, \*Wastewater treatment, Economic aspects, Governmental interrelations, Incineration, Land reclamation, Landfills, Policy making, Public participation.

The increase in sewage treatment in western Europe has created more sludge for disposal. This increase has attracted public and political attention, but managers have to take daily responsibility for the actual practice of disposal. Nevertheless, regional and national policies and laws influence the freedom of choice of managers. In simple terms managers must dispose of sludge in environmentally self-legal ways which increase maintained. managers must dispose of sludge in environmentally safe, legal ways which incur minimum costs.
Sludge disposal options include agricultural utilization, waste disposal sites in landfill, land reclamation, incineration, and marine disposal. Utilization
of wastes is often tied to marketing. The rise in unit
costs and mass of sludge for disposal will mean
that the sums expended on treatment and disposal
will become substantial business for disposers,
equipment suppliers, contractors and farmers. The
problems facing managers vary widely from counequipment suppliers, contractors and farmers. The problems facing managers vary widely from coun-try to country, but sludge disposal is always a challenge. (See also W91-11115) (Brunone-PTT) W91-11122

REMOVAL OF HEAVY METALS FROM SEWAGE SLUDGE: STATE OF THE ART AND PERSPECTIVES.

Hoofdgroep Maatschappelijke Technologie TNO, Apeldoorn (Netherlands). W. H. Rulkens, F. van Voorneburg, and J.

JUZIASSE.

IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 145-159. 1 fig, 5 tab, 26 ref.

Descriptors: \*Cost analysis, \*Heavy metals, \*Land disposal, \*Sludge treatment, \*Waste treatment, \*Wastewater treatment, Biological treatment, Chemical treatment, Comparison studies, Economic aspects, Microorganisms, Sludge drying.

Land application of sewage sludge is increasingly limited due to the presence of heavy metals. Based on data from literature and on laboratory-scale experimental research, technical and economic imexperimental research, technical and economic improvement of sludge quality is made possible by removing a substantial part of these heavy metals from the sludge. The principal methods to serve this purpose are extraction with inorganic acids, with complexing agents, or with microorganisms of the genus Thiobacillus. Generally, with these methods removal of 70% to 100% of the heavy metals is possible. In order obtain high removal percentages rather extreme conditions often have percentages rainter extenie conditions often have to be applied. Due to these extreme conditions, treatment costs are relatively high. Consequently, none of the methods is presently applied at a practical scale. A rough cost estimate indicates that the treatment costs amount to about Dfl. 300 to office of the control of the control of the control of the control of a polication of a process, a two-fold cost reduction as probably essential. Potential methods for cost reduction are decrease of treatment time, higher reduction are usercase of uncannent unit, inguier initial dry solids concentration, or reuse of extracting agent. Experimental research is necessary to verify the feasibility of these cost reduction methods. (See also W91-11115) (Author's abstract) W91-11124

IMPROVEMENT OF THE QUALITY OF SEWAGE SLUDGE: MICROBIOLOGICAL AS-

Hohenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Tiermedizin und Tierhygiene.

D. Strauch. IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environ-mental Effects. Elsevier Science Publishing Co., New York. 1989. p 160-179. 12 tab, 6 ref.

Descriptors: \*Disinfection, \*Human pathogens, \*Microorganisms, \*Sludge treatment, \*Waste treatment, \*Wastewater treatment, Aerobic digestion, Anaerobic digestion, Bacteria, Bioindicators, Composting, Hydrogen ion concentration, Temperature, Viruses.

For the improvement of the microbiological quality of sewage sludge only disinfection methods can be recommended which inactivate pathogenic agents like bacteria, viruses and parasite ova. In a comprehensive study, raw and treated sludges from conventional sewage treatment plants were microbiologically investigated for potential indicator organisms. Selected indicators were tested for mperature and pH resistance. Finally, dis fected sludges from eight sewage treatment plants with different installations for sludge disinfection were microbiologically analyzed to control the effectiveness of the disinfection systems. Based on effectiveness of the disinfection systems. Based on the results of these microbiological studies, param-eters for the hygienic evaluation of disinfection methods were elaborated from a working group as well as proposals for definitions of process descrip-tion and control for pasteurization, aerobic-ther-mophilic stabilization (ATS), ATS with subsequent respectively disestions. anaerobic mesophilic digestion, treatment with Ca(OH)2, composting in windrows and in-vessel-composting (reactors). (See also W91-11115) (Author's abstract) 91-11125

HIGH-PRESSURE DEWATERING WITH POLYMER CONDITIONING AS A PREREQUISITE FOR THE ENERGY-INDEPENDENT INCIDENTALION OF SEWAGE SLUDGE.

Abwasser-Abfall-Aquatechnik, Darmstadt (Gersent E.P.)

many, F.R.).

Dr. Sowage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York: 1989. p 189-198. 2 fig, 2 tab, 11 ref.

Descriptors: \*Incineration, \*Sludge disposal, \*Sludge drying, \*Sludge thickening, \*Sludge treatment, \*Wastewater treatment, Cost analysis, Economic aspects, Energy use efficiency, Floccula-

Volume reduction, and in particular ballast-water extraction, are a central feature in the sewage sludge disposal process, irrespective of the operational procedures employed. An important requirement in sludge dumping is that, whenever possible, only original sludge constituents and not additional ballast substances of an inorganic nature should be allowed to take up the finite dumping space available. For the purpose of ensuring energy-independent sewage incineration, the original dry mass of the sludges needs to be enriched to dry matter levels of between 30% and 35%. To achieve this objective, high-pressure dewatering units, such as chamber filter presses, continuous dry matter levels of between 30% and 35%. To achieve this objective, high-pressure dewatering units, such as chamber filter presses, continuous high-pressure (CHP) filter presses, or centripresses must be used. In the event of conditioning with organic flocculating adjuvants, several different dewatering units can be used. The price of increased dewatering efficiency will be increased energy consumption, longer pressing times and/or increased flocculating agent consumption. (See also W91-11115) (Brunone-PTT)

SLUDGE DEWATERING TECHNOLOGY IN PERSPECTIVE

KHD Humboldt Wedag A.G., Cologne (Germany,

F.R.). H. H. Gildemeister.

H. H. Glidemeister. In: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 199-218. 13 fig, 11 ref.

Descriptors: \*Sludge drying, \*Sludge thickening, \*Sludge treatment, \*Wastewater treatment, Com-parison studies, Cost analysis, Pressure filtration, Sludge disposal, Sludge filters.

The dewatering of sludges is an unavoidable but The dewatering of sludges is an unavoidable but very important step to solve environmental problems of sewage plants. The cost of sludge disposal can only be reduced effectively if the quantity of dumped substances is minimized. Both Centripress and HI-COMPACT, two processes developed with a future perspective to achieve maximum mechanical dewatering of sludges can be very important. Centripress is an improved version of the conventional decanter in which, by using a squeeze-press effect, the dewatering result of the the conventional decanter in which, by using a squeeze-press effect, the dewatering result of the cake can be improved by about 5% to 10% dry weight. In comparison, HI-COMPACT is a completely new process for the mechanical dewatering of sludge using pressure. In this process, a drainage system is effectively introduced into a filter compact to enforce an optimum dewatering of the sludge. Compared to conventional processes, about 60% of the residual water can be pressed out of the filter compact. Solid substances in the range of 55 to 65 mass-% can easily be achieved by this process. Because of considerable reduction in quantities of disposable substances, both processes can be economically employed to solve today's increasing economically employed to solve today's increasing disposal problems. (See also W91-11115) (Author's W91-11128

TECHNICAL REQUIREMENTS AND POSSI-BILITIES OF INCINERATION.

Istituto di Ricerca sulle Acque, Bari (Italy). L. Spinosa, and V. Lotito.

In: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 223-235. 11 tab, 18 ref.

Descriptors: \*Incineration, \*Sluc \*Sludge \*Sludge treatment, \*Waste treatment, \*Wastewater treatment, Agriculture, Air pollution, Ash, Landfills, Leaching, Particulates, Scrubbers,

Sewage sludge incineration can be considered as a valid alternative when other ways of disposal are not applicable, due to the presence of noxious substances (agricultural use) and lack of suitable sites (landfill). Moreover, technological improve-ments allow a safe, efficient and cheap operation to be obtained. The types of equipment most widely used are the multiple hearth and fluidized bed furnaces. Multiple hearth furnaces require less auxiliary fuel, in absence of after-burning; fluidized iliary fuel, in absence of after-burning; illudized bed furnaces provide more flexibility in operation and a more efficient combustion, even with low excess air. Main pollution problems arise from gaseous emissions and ash disposal. Particulates can be efficiently removed by either wet systems or dry ones, sulfur dioxide and hydrochloric acid controlled by scrubbers, and emissions of odors and organic compounds reduced by after-burning. and organic compounds reduced by after-burning; catalytic reduction is the only technique able to remove NOx. Ash is commonly landfilled; the leachate contamination seems to be generally comparable with that of municipal refuse landfill and is paraote with that of municipal tetuse inautin and strongly affected by chemicals used during sludge treatment with the exception of cadmium, iron and aluminum salts cause the highests leachability of trace metals. (See also W91-11115) (Author's ab-W91-11129

ENVIRONMENTAL ASPECTS OF SLUDGE IN-CINERATION: OVERVIEW.

Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.).

For primary bibliographic entry see Field 5E. W91-11130

SEWAGE SLUDGE INCINERATION AND UTI-LIZATION OF ENERGY. BASF A.G., Ludwigshafen am Rhein (Germany,

F.R.). R. Romer.

IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 252-265. 14 fig, 4 ref.

### **Group 5D—Waste Treatment Processes**

Descriptors: \*Incineration, \*Sludge disposal, \*Sludge treatment, \*Wastewater treatment, Energy conservation, Sludge conditioning, Sludge drying, Steam, Sulfuric acid

For municipalities and industries, sewage sludge from biological wastewater purification plants is becoming an increasingly large disposal problem. Fluidized bed furnaces with subsequent waste heat boilers and air preheaters have gained general acceptance because of their operating safety and simplicity. Temperatures above 700 C are adequate for certain ignition of sewage sludge. Because of SO3 formation during incineration, sulphuric acid dew points of 130 to 150 C must be expected. The degree of dewatering of the sewage sludge is the key to the utilization of energy from sludge incineration. The energy contained in the dry sludge is usually not enough to permit independent combustion at temperatures of 950 C. The amount of steam that can be produced per ton of dry sludge can be estimated as a function of water load, air pre-heating and conditioning. With decreasing water load, the specific flue gas volume rises. Predrying of the sewage sludge with steam from incineration waste heat energy recycling allows a fur-For municipalities and industries, sewage sludge eration waste heat energy recycling allows a fur-ther reduction in installation size compared with conventional fluidized bed incineration. In terms of minimum plant size and minimum additional fuel requirements, heat disposal of sewage sludge by fluidized bed incineration with utilization of the waste heat and use of the steam produced to predry the sludge is the optimum solution. The conventional fluidized bed method is often preferred, especially when the steam produced can be usefully employed for network steam, power or electricity, and district heating. (See also W91-11115) (Brunone-PTT) W91-1113 conventional fluidized bed incineration. In terms of

SLUDGE TREATMENT IN AMSTERDAM: ECONOMICAL, TECHNICAL AND ENVIRONMENTAL EXPERIENCES.

Dienst Openbare Werken, Amsterdam (Nether-

R. R. Kruize.

IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 266-277. 5 fig. 6 tab.

Descriptors: \*Incineration, \*Sludge analysis, \*Sludge drying, \*Sludge treatment, \*The Netherlands, \*Wastewater treatment, Polymers, Sludge digestion, Sludge filters.

The possibilities of recycling sludge in the Netherlands are decreasing because the quality standards for sludge which may be used for compost production have become more stringent. Sludge incineration is one alternative. Based on the practical ation is one alternative. Based on the practical experiences with sludge dewatering in filter presses after conditioning with polymers and the introduction of a sludge incineration plant at the wastewater treatment plant Groote Upolder, Amsterdam has developed a strategy for sludge treatment. All sludge will be transported to the wastewater treatment plant Amsterdam East. The sludge incineration plant with a capacity of approximately 1.2 million population equivalent (80 tons d.s./day) will consist of sludge digestion and dewatering in filter presses (or centripresses). (See also W91-11115) (Author's abstract)

STATUS REPORT ON ENVIRONMENT CAN-ADA'S OIL FROM SLUDGE TECHNOLOGY. Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre. . Campbell.

H. W. Campbell. IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 281-291. 3 fig. 2 tab, 10 ref.

Descriptors: \*Sludge digestion, \*Sludge treatment, \*Sludge utilization, \*Synthetic fuels, \*Wastewater treatment, Aerobic digestion, Anaerobic digestion, Economic aspects, Oil, Sludge thickening.

Environment Canada has been assessing the viability of thermally converting sewage sludge to liquid

and solid fuels, over the past six years. The experiand solid fuels, over the past six years. The experimental evaluation has been completed on a 1 kg/h bench-scale reactor and a 40 kg/h pilot plant. Oil yields have ranged from a low of 13% for an anaerobically digested sludge to a high of 46% for a mixed raw sludge. Char yields have ranged from 40 to 73% at the optimum operating temperatures. Fundamental mechanisms involved in the thermal liquefaction are that raw sludges produce higher yields of oil, but these usually have a higher viscosity than oils from digested sludges. Thermally produced sewage sludge oils are mainly lipid in origin. The process is currently being tested in a continu-The process is currently being tested in a continu-ous mode on the bench-scale reactor. A pilot plant will be operated for a 6 to 9 month period to generate large volumes of oil for market evaluation. (See also W91-11115) (Brunone-PTT)

THERMOPHILIC AEROBIC STABILISATION.

HERMOPHILIC AEROBIC STABILISATION. Eidgenossische Technische Hochschule, Zurich (Switzerland). Dept. of Biotechnology. A. Fiechter, and B. Sonnleitner. IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 291-301. 7 fig, 2 tab, 15 ref.

Descriptors: \*Aerobic digestion, \*Sludge digestion, \*Sludge treatment, \*Switzerland, \*Thermophilic bacteria, \*Wastewater treatment, Biological treatment, Cost analysis, Kinetics, Process optimi-

Aerobic thermophilic sludge treatment (ATST) from sewage plants is an efficient process for hygienization and stabilization in large-scale and small-scale second stage procedures. However, reaching economical and reliable operation over the entire year cycle is difficult. Problems include the entire year cycle is difficult. Problems include definitions of objectives for process optimization up to control strategies and the integration of ATST into complete concepts for sewage plants. Careful planning of strategies for ATST consists basically of the selection of appropriate process objectives yielding a product suitable for further use or safe deposition. Temperature plays a central role in ATST. Thermophilic bacteria appear most suitable for application in ATST plants, due to their particular metabolic properties. They are widespread in nature and accumulate in sludge from sewage treatment plants. Their elevated metabolic kinetics lead to temperature increases suitaabolic kinetics lead to temperature increases suita-ble for thermal hygienization of the final product. Preliminary results with ATST are most encourag-ing. Experimentation will provide a sound basis for future optimization of the 880 sewage treatment plants presently operated in Switzerland. (See also W91-11115) (Brunone-PTT)

### INFLUENCES ON THE MECHANICAL PROP-ERTIES OF SEWAGE SLUDGE FOR DISPOS-AL TO LANDFILL.

Ruhr Univ., Bochum (Germany, F.R.). Lehrstuhl fuer Wasserwirtschaft und Umwelttechnik II. R. Otto-Witte.

R. Otto-Witte. IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co, New York. 1989. p 307-324. 17 fig. 1 tab, 8 ref.

Descriptors: \*Sludge disposal, \*Sludge treatment, \*Sludge utilization, \*Wastewater treatment, Drain-age, Mechanical properties, Sludge drying, Sludge filters, Total solids.

The most significant property of sludges to be landfill disposed is not that of dry solid matter, but their shearing strength. A shearing strength higher than 15 to 20 kN/sq m, which is the minimum strength, determined by the minimum working value, could not normally be reached by dewatering with belt filter presses or centrifuges, even where the parameters of the machine had been optimized. Adding quicklime before or after mechanical dewatering increases the shearing strength. Three types of laboratory apparatus were tested: vane apparatus for measuring the vane tested: vane apparatus for measuring the vane shear strength, fall-cone apparatus for measuring the cone shear strength, and pressure device for

measuring bearing capacity. Higher proportions of combined drainage bring higher sludge strengths regardless of the type of dewatering. When dewatering with conventional filter presses a slight negative influence of increased solids contents was seen in the input on the final solids content, while the influence on the mechanical properties of the sludge was indetermined. Sludges dewatered with the mittence on the mechanical properties of the sludge was indeterminate. Sludges dewatered with belt filter presses and centrifuges using only polyelectrolytes for conditioning do not generally attain the vane shear strength of 15 to 20 nM/sq m, without subsequent treatment. (See also W91-11115) (Brunone-PTT)
W91-11135

SLUDGE RECYCLING IN AGRICULTURE COMPARED WITH OTHER DISPOSAL METHODS IN FRANCE.

Department of Water and Pollution and Hazard Avoidance, Ministry of the Environment, France. For primary bibliographic entry see Field 5E. W91-11137

USE OF MUNICIPAL SEWAGE SLUDGE IN AGRICULTURE: THE ROLE OF THE WATER AUTHORITIES.

Pollution Control Department, ARTOIS-PICAR-DY, France.

B. Godfroy.

B. Odorroy. IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 352-355. 1 tab.

Descriptors: \*France, \*Sludge disposal, \*Sludge treatment, \*Sludge utilization, \*Wastewater treatment, Agriculture, Catchment areas, Environmental effects, Regulations, Soil analysis.

Six water authorities have been created in France to combat water pollution and improve management of available resources: Artois-Picardy, Adour-Garonne, Loire-Brittany, Rhine-Meuse, Rhone-Mediterranean-Corsica, and Siene-Normandy. The six authorities have championed, in their respective catchment areas, the introduction of satisfactory sludge treatment and disposal methods, which include those intended for use in agriculture. The sludge treatment problem has been targeted since the authorities launched their first programs in the early 1970's, but the municipalities could not make maior progress in treating Six water authorities have been created in France grams in the early 1970's, out the minicipanties could not make major progress in treating wastewater as long as the operators were unable to draw off and treat sludge at regular intervals and dispose of it in an environmentally safe place. While significant results have been obtained over a ten-year period, much remains to be done with regard to improved treatment plants, spreading machinery, sludge and soil analysis, record keeping, etc. (See also W91-11115) (none-PTT) W91-11138

#### EXAMPLES OF AGRICULTURAL USE OF RE-SIDUAL SLUDGE.

R. Delauzanne, and J. M. Merillot.

In: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 356-360. 3 tab.

Descriptors: \*Agriculture, \*France, \*Sludge conditioning, \*Sludge disposal, \*Sludge utilization, \*Wastewater treatment, Filter presses, Land disposal, Polymers, Sludge drying, Sludge filters.

Successful use of sewage sludge in agriculture depends on coordinated organization of sludge production, processing and spreading. The town of Cholet has a sewage works with a nominal capacity of 120,000 population equivalent (pe) (biological filters). The sludge is thickened, methanated, hen dewatered on belt filter presses and conditioned with polymers. Sludge production in 1985 amounted to 600 tons of dry matter, which was applied to fields used for the cultivation of maize and rye grass. The municipal technical services keep comprehensive records for efficient management of the system, information meetings are held twice or three times a year, and agronomic moni-

### Waste Treatment Processes—Group 5D

toring of sludge quality. The Bailleul local authority consortium runs a sewage plant with a capacity of 100,000 pe, the loading rate of which varies between 40 and 100%. The 650 tons of sludge dry matter produced annually are dewatered by centrifuging and stabilized with quicklime. The sludge is applied to silt and clay soils, used for production of potatoes, beets, maize, cereals, and pastureland. Farmers are responsible for transport and spreadrarmers are responsible for transport and spreading. Agronomic monitoring is carried out by the Nord Chamber of Agriculture. In both cases, the activities have been designed to respond specifically to the choice of agricultural use of sludge and its constraints. The storage and dewatering units provide the required flexibility, both in respect of the sewage plant/collection station interface and of sludge utilization by farmers. (See also W91-11115) (Brunone-PTT) W91-11139

SLUDGE TREATMENT AND TIPPING SITE 'HARTELMOND'.
Hollandse Eilandenen Waarden Wastewater Authority, Dordrecht (Netherlands).
J. H. B. Marvelde.

J. H. b. Marveiur IN: Sewage Sludge Treatment and Use: New De-velopments, Technological Aspects and Environ-mental Effects. Elsevier Science Publishing Co., New York. 1989. p 361-363. 1 fig. 1 ref.

Descriptors: \*Sludge disposal, \*Sludge drying, \*Sludge treatment, \*The Netherlands, \*Wastewater treatment, Land disposal, Landfills, Sludge thickening.

In Rotterdam, three new wastewater treatment plants have been built during the last few years. The disposal of the large quantity of sludge is a major problem in this urban and industrial area. At the Hartelmond site dewatered sewage sludge is dried before dumping in a single sludge landfill. The natural drying process in the period April to September is improved by mechanical turning 2 to 3 times a week. In a period of 4 to 8 weeks, the 3 times a week. In a period of 4 to 8 weeks, the shear strength measured by a vane tester increases from 2.5 kN/sq nto 10 to 20 kN/sq nt (from 17 to 18% ds to 30 to 35% ds). At the Hartelmond landfill 10 kN/sq m is used as a limit for the acceptance of the sludge. Then the sludge is solid enough for dumping in a single sludge landfill. (See also W91-11115) (Author's abstract) W91-11140

STABILIZATION OF SEWAGE SLUDGE AND ITS DISINFECTION ACCORDING TO SPECIF-IC REQUIREMENTS: TWO-STAGE ANAERO-BIC/AEROBIC OPERATING TECHNIQUES,

Lahmeyer International GmbH, Lyon 22, D-6000, Frankfurt, Germany.

U. stoil. IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 364-369. 3 fig, 1 ref.

Descriptors: \*Disinfection, \*Germany, \*Sludge digestion, "Sludge stabilization, "Sludge treatment,
"Wastewater treatment, Aerobic digestion, Anaerobic digestion, Biogas, Biological treatment, Regulations, Temperature.

lations, Temperature.

About 50 million cubic m raw sludge are produced per year in the nearly 10,000 sewage treatment plants of West Germany. The legal prescriptions for its treatment and disposal have become increasingly strict in recent years. Due to the limited dumping ground capacities, the disposal of sewage sludge, is increasingly difficult. The solution is to increase recycling of a greater volume of sewage sludge, provided that recycling is technically and economically practical and ecologically reasonable. The operating technique developed is future-oriented. The two-stage operating technique guarantees stabilization and disinfection at the same time and leads to a considerable energy profit. In an initial anaerobic stage, the sludge will be digested resulting in usable energy in the form of biogas. The primary purpose of the treatment in this first stage, anaerobic digestion, is the stabilization of the sludge. In the second stage, the sewage sludge is treated aerobically. During digestion the sludge

heats up to temperatures of more than 50 C which results in disinfection. For self-acting biological heating of the sludge that does not reach 50 C, a separate heating system must be installed in the aerobic reactor. The primary purpose of the second stage is the disinfection of sewage sludge, if required. (See also W91-11115) (Author's abstract) W91-11141

BAN ON PHOSPHORUS IN DETERGENTS: BAN ON PHOSPHORUS IN DETERGENTS:
THE EFFECTS ON THE PHOSPHORUS CONTENTS OF SWISS SEWAGE SLUDGES AND
ON THE EFFICIENCY OF PHOSPHORUS
ELIMINATION BY SEWAGE TREATMENT PLANTS.

PLANIS. Eidgenoessische Forschungsanstalt fuer Agrikul-turchemie und Umwelthygiene, Bern (Switzer-

T. Candinas In: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 370-377. 4 fig. 6 tab, 3 ref.

Descriptors: \*Detergents, \*Phosphorus, \*Sludge treatment, \*Switzerland, \*Wastewater treatment, \*Water pollution control, Fertilizers, Nutrient concentrations. centrations. Precipitation

The total phosphorus load in the sewage of Switzerland decreased with the phosphorus ban from approximately 15,000 tons/year to 11,000 tons/year. At the same time, the phosphorus load in sewage sludge decreased a mere 1200 tons/year, from 7000 to 5700 tons/year. Thus, the phosphorus load discharged into the main channel by the sewerage system was reduced from 8000 to 5400 tons/year. The efficiency of phosphorus elimination in sewage plants with precipitation is still about the same (approximately 80%), whereas the efficiency has been improved in sewage plants without phosphorus precipitation from 40% to 50%. The value of sewage sludge as phosphorus fertilizer diminished insignificantly in sewage plants working without phosphorus precipitation (reduction of the average phosphorus contents from 22 to 19 P/t minimus phosphorus precipitation (reduction of the average phosphorus contents from 22 to 19 P/t DM). Sludges from sewage plants precipitating phosphorus show a much lower phosphorus content. (See also W91-11115) (Author's abstract) W91-11142

AEROBIC-THERMOPHILIC METHODS FOR DISINFECTING AND STABILIZING SLUDGE, Fuchs Gastechnik and Wassertechnik G.m.b.H.,

Mayen (Germany, F.R.).

J. Jakob, H. J. Roos, and K. Siekmann.

IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 378-389. 8 fig, 11 ref.

Descriptors: \*Aerobic digestion, \*Disinfection, \*Germany, \*Sludge digestion, \*Sludge stabilization, \*Sludge treatment, \*Wastewater treatment, Agriculture, Cost analysis, Efficiency, Odors, Regulations, Sludge utilization, Soil amendments, Thermophilic bacteria.

In accordance with the Sewage Sludge Ordinance, in Germany only hygienically pure sewage sludge may be used on green fields and fields which are used for the cultivation of field forage since January 1, 1987. The use of the autoheated thermophilic aerobic digestion method which was introduced to the market by the FUCHS Gastechnik and Wassertechnik GmBH, can guarantee both the dissipation and the necessary stabilization of the infection and the necessary stabilization of the sludge (to reduce odor). More than 35 autoheated studge (to feutee odor). More than 3 autofleated thermophilic aerobic digestion plants, employing the FUCHS system have been operating world-wide very successfully in both domestic and indu-trial sewage facilities. Extensive examinations of trial sewage facilities. Extensive examinations of installations in operation confirm the high degree of efficiency and the economy of the method. Based on experiences gained with aerobic thermophilic sudge digestion during the last few years, the aerobic thermophilic method has found further areas of application, including the aerobic (mesophilic or thermophilic) preliminary stage for the relief of existing anaerobic digestion and, if necessary, the simultaneous disinfection. (See also W9111115) (Author's abstract)

W91-11143

CHEMOLYSIS PROCESS OF DOW STADE

Wasserwirtschaft Stade (Germany, F.R.) H. Reincke.

In: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 390-392. 3 fig.

Descriptors: \*Chemical treatment, \*Sludge thick-ening, \*Sludge treatment, \*Wastewater treatment, Biological treatment, Decomposition, Sludge disposal, Sludge filters.

In biological purification plants, organic waste is decomposed through the metabolism of microorganisms. Wastewater is mixed with bacteria-rich sludge, which is then decomposed to water and carbon dioxide through the bacterial digestive process. The Dow Chemolysis process for the experience of the control process. The Dow Chemolysis process for the reduction of excess biox sludge crastically reduces the volume of sludge created by biological purification, by transforming organic compounds so that biologically easily decomposable building blocks are produced. The results show a >80% reduction of filtercake production. The process is suitable for the community as well as industrial use to fundamentally alleviate the pressing waste disposal probmentally alleviate the pressing waste disposal prob-lem. (See also W91-11115) (Brunone-PTT) W91-11144

EXTRACTION OF HEAVY METALS FROM SLUDGES AND MUDS BY MAGNETIC ION-EXCHANGE.

Commonwealth Scientific and Industrial Research Organization, Melbourne (Australia). Div. of Chemicals and Polymers. E. A. Swinton, R. J. Eldridge, and N. S. C.

IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 393-404. 9 fig, 6 tab, 8 ref.

Descriptors: \*Heavy metals, \*Ion exchange, \*Separation techniques, \*Sludge disposal, \*Sludge treatment, \*Wastewater treatment, Bases, Chemical properties, Chlorine, Effluents, Hydrogen ion concentration, Landfills, Mud, Sulfuric acid.

A recent development in ion-exchange technology has the potential for attacking the problem of heavy metals in sludges and muds. Ion-exchangers manufactured in the form of magnetic beads can be recovered from sludges by the magnetic drum separators which are commonly used in the mineral and coal industries. Operation of a pilot plant has shown that the ion-exchangers can be recovhas shown that the ion-exchangers can be recovered with as little as 5 ml leakage per kl of sludge. The chemistry of the proposed process has been investigated in the laboratories of CSIRO. Sludge is stirred with a small quantity of magnetic ion-exchanger, together with a small dose of chlorine, at a pH of 2.5 to 3.0 for 30 to 60 minutes. The ion-exchanger is recovered, regenerated by dilute sulfuric acid and recycled. The acid effluent is precipitated by the lime to give a small volume of hydroxide sludge which would be disposed of in controlled landfill. Possible applications of this technology to any particular sludge can readily be assessed in the laboratory using conventional ion-exchange resins. (See also W91-11115) (Author's abstract) abstract) W91-11145

WET OXYDATION AS THE ALTERNATIVE FOR SEWAGE SLUDGE TREATMENT. GRONTMIJ N.V., De Bilt (Netherlands).

P. H. A. M. J. de Bekker, and J. J. van den Berg IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 407-421. 3 fig., 1 tab, 7 ref.

Descriptors: \*Sludge disposal, \*Sludge treatment, \*The Netherlands, \*Wastewater treatment, \*Wet

### **Group 5D—Waste Treatment Processes**

oxidation process, Oxidation, Oxygen, Separation techniques, Sludge thickening.

The quantities of sludge in the Netherlands in relation to the surplus of animal manure and the lack of space for landfilling requires other sludge treatment processes, one of which is the wet oxidatreatment processes, one of which is the wet oxidation process. The wet oxidation process is comparable in the solids reducing capacity to incineration, without the disadvantages of dewatering, flue gases and probably reusable ash. The Vertech process is an interesting example of wet oxidation: a set of tubes is drilled vertically into the ground at a length of approximately 1500 m. High pressure is obtained by the sludge column, heat is generated by the process itself after start-up and only (pure) oxygen has to be added to start the process. After separation of the ash, the off-gases and the liquid dewatering of ash takes place, gases are treated by thermal after-burning, and the liquid is biologically treated. Wet oxidation is an environmentally acceptable alternative for sewage sludge treatment. (See also W91-11115) (Author's abstract)

HEAVY METAL SPECIATION IN SEWAGE SLUDGE FOLLOWING A PHYTO-DEWATER-ING TREATMENT.

Consiglio Nazionale delle Ricerche, Pisa (Italy).

Ist. di Chimica Terreno.
S. Canarutto, L. Lubrano, M. C. Negri, and G. Petruzzelli

Petruzzelli. In: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 422-426. 2 fig. 1 ref.

Descriptors: \*Biological treatment, \*Evapotran-spiration, \*Heavy metals, \*Path of pollutants, \*Sludge drying, \*Sludge treatment, \*Wastewater treatment, Copper, Plant growth, Speciation, Zinc.

Speciation of heavy metals in sewage sludge de-pends both on source and treatment of sludge. The different metal species are affected by interactions with adsorbing surfaces of a soil which can miti-gate metal contamination and toxicity. Chemical forms of heavy metals have been investigated in sewage sludge to evaluate changes following variations in environmental conditions via phytodewaations in environmental conditions via phytodewatering. Phytodewatering is founded on the plant evapotranspiration process to remove water from sewage sludge. The process involves cultivation of fast-growing vegetables with high water requirements on a substrate constituted by the sewage sludge itself. The phytodewatering procedure represents a possible alternative to traditional drying processes of sludges. In both sludges, heavy metals in mobile chemical forms accounted for 10% to 50% of total content. Significant quantities of bioa-vailable metals extractable by EDTA were recovered, particularly for zinc and copper which were about 25% and 15%, respectively, of the total content in sewage sludge. (See also W91-11115) (Brunone-PTT) W91-11147

COMPOSTING RAW SEWAGE SLUDGE IN COMPOSTING RAW SEWAGE SLUDGE IN THE ABSENCE OF BULKING AGENTS. Istituto di Microbiologia Agraria e Stazione de Microbiologia Industriale, Portici (Italy). For primary bibliographic entry see Field 5E. W91-11149

PRODUCTION OF COM SEWAGE SLUDGE IN TOKYO. COMPOST FROM Tokyo Sewerage Bureau (Japan). For primary bibliographic entry see Field 5E. W91-11153

BENEFICIAL UTILIZATION OF INCINERAT-ED ASH AND MELTED SLAG. Public Works Research Inst., Tokyo (Japan). For primary bibliographic entry see Field 5E. W91-11154

SLUDGE DEWATERING: FIRST MEMBRANE FILTERPRESS PLANT IN THE NETHER-LANDS OPERATIONAL.

P. J. Rooijmans

In: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 493-495. 2 tab.

Descriptors: \*Sludge conditioning, \*Sludge drying, \*Sludge filters, \*Sludge treatment, \*The Netherlands, \*Wastewater treatment, Incineration, Polyelectrolytes

At the municipal wastewater treatment plant in Hengelo, The Netherland, the first membrane fil-Hengelo, The Netherland, the first membrane filterpress plant for sewage sludge dewatering in the Netherlands has become operational. The plant is designed to treat 250 cubic m digested sludge, 5% dry solids, 8 hours per day. Two membrane filterpresses, each consisting of 138 chambers are the heart of the plant, designed by Witteveen+Bos Consultants, by order of the polder board Regge en Dinkel. The operational results in the first period were quite satisfactory. The sludge cake dry solids content was 40% +/-4%, while the complete process cycle (filling, dewatering, and sludge cake discharge) took only 1.25 to 1.5 hours. When future developments require drying or comsludge cake discharge) took only 1.25 to 1.3 hours. When future developments require drying or combustion of the sludge cake, sludge conditioning with polyelectrolytes may be beneficial, and is easily fit into the membrane filterpress system. Therefore, sludge dewatering in membrane filterpresses is not only a useful method for creating a sludge cake that can be dumped, but also a useful pretreatment method for sludge drying or combus-tion. (See also W91-11115) (Brunone-PTT) W91-11155

SLUDGE STUDIES ON SLUDGE MANAGE-MENT: STRATEGIC STUDIES ON SLUDGE.

Witteveen and Bos, Deventer (Netherlands).
H. A. A. M. Webers.
IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 496-498.

Descriptors: \*Sludge disposal, \*Sludge treatment, \*Sludge utilization, \*The Netherlands, \*Wastewater treatment, Cost analysis, Recycling, Regulations, Sludge drying.

Sewage sludge from wastewater treatment plants is Sewage sludge from wastewater treatment plants is a growing problem due to the lack of facilities for sludge treatment and disposal. In general, two ways to remove sewage sludge exist: recycling, and processing and dumping of the end product. Strategic studies on sludge management are especially developed to evaluate specific possibilities for the treatment and disposal of sludge for a water quality authority. These follow six phases: inventory of present and future situations, survey of methods for processing development of a cost model. ods for processing, development of a cost model for various treatment and disposal methods, eval-uation of treatment methods, development of treatment scenarios for consecutive plan periods, and conclusions and recommendations for a long-term sludge management policy and for short-term measures. In regards to the present Dutch quality standards for sewage sludge, the maintenance of land application for smaller sewage treatment ianu application for smaller sewage treatment plants is recommended. For dewatering installa-tions above approximately 5000 tons dry solids/ year scale increases will hardly diminish annual treatment costs. (See also W91-11115) (Brunone-PTT) W91-11156

PESTICIDES AND DRINKING WATER INFOR-MATION: A PERSPECTIVE FROM EPA'S NA-TIONAL PESTICIDE SURVEY.

ItoNAL PESTICIDE SURVEY.
O. Corey.
IN: Agrichemicals and Groundwater Protection:
Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 145-151.

Descriptors: \*Drinking water, \*Nonpoint pollution sources, \*Pesticides, \*Surveys, \*Water analysis, Administrative agencies, Data interpretation, Information exchange, Information systems, Information transfer, Networks, Water quality, Well

The Environmental Protection Agency's (EPA) National Pesticide Survey is a two year study of pesticide contamination in drinking water wells. Data for the Survey is being obtained by sampling 600 community water system wells and 750 private wells across the country. The Survey tests EPA sampling techniques, laboratory methods, and relationships with State agencies which are crucial to the success of the Survey. Two different EPA-funded information networks are used to reach tionships with State agencies which are crucial to the success of the Survey. Two different EPA-funded information networks are used to reach those who are concerned with the issues raised in the Survey. One is the National Pesticides Telecommunications Network (NPTN) which is funded by the EPA's Office of Pesticide Programs and operated by the Department of Preventive Medicine and Community Health of the School of Medicine and Community Health of the School of Medicine at the Texas Technical University Health Sciences Center. NPTN provides non-emergency information on product chemistry, safety precautions, health and environmental effects, clean-up, and disposal. The second network is the Safe Drinking Water Hotline which is funded by EPA's Office of Drinking Water and operated by GEO Resource Consultants. The Hotline answers questions about contaminants, drinking water standards, and the National Pesticide Survey. In addition to the two information networks, health advisory briefs will also be a result of the Survey. The sory briefs will also be a result of the Survey. The briefs identify, for each contaminant, the level of briefs identify, for each contaminant, the level of chemical concentration which is acceptable in the drinking water. The briefs will explain adverse health effects that may occur in concentrations above the acceptable health advisory level and outline options for preventive measures that can be taken to ensure the safety of the drinking water supply. (See also W91-11162) (Korn-PTT) W91-11173

RECTANGULAR CLARIFIERS SHOULD BE CONSIDERED.

Greeley and Hansen, Chicago, IL. T. E. Wilson.

Water Engineering and Management WENMD2, Vol. 138, No. 4, p 20-22, April 1991. 2 fig, 11 ref.

Descriptors: \*Clarifiers, \*Sanitary engineering, \*Wastewater treatment facilities, Biological wastewater treatment, Circular clarifiers, Comparison studies, Design criteria, Performance evaluation, Rectangular clarifiers, Suspended solids, Wastewater treatment.

In recent years the number of designers designing rectangular clarifiers has declined. This appears to be particularly true for clarifiers following some activated sludge aeration basins. It has been asserted by some that rectangular clarifiers require 25% more settling area than circular clarifiers, but the author has not found this to be the case. Another issue is depth. Experience has shown that both types of clarifier can work well at depths as shallow as 8 ft. One of the biggest advantages of rectangular clarifiers is that they require less space. It takes 79% as much space to site a rectangular clarifier as a circular clarifier with the same surface clarifier as a circular clarifier with the same surface area. Common-wall construction also saves space and construction costs for a rectangular clarifier. Operation of rectangular clarifiers is straightforward and generally does not differ significantly from circular clarifiers with scraper-type collectors. The need to replace collector chains has been a disadvantage of rectangular clarifiers in the past, but recent experience shows that replacement only once in 5 yr is needed in many cases, and the life span may increase further with the use of non-metallic chains. Effluent suspended solids concentrations below 10 mg/l are achievable surfacemetainc chains. Erituent suspended soince concentrations below 10 mg/l are achievable surface-overflow rates (SORs) up to at least 1000 gallons/ day/sq ft. Rectangular clarifiers have been added recently to large wastewater facilities in Little Rock, Philadelphia, New York, and Phoenix, but rectangular collectors are being replaced by circular collectors in Los Angeles. The future of this issue remains unclear. (See also W91-11224) (Rochester-PTT) W91-11223

CASE FOR CIRCULAR CLARIFIERS. Brown and Caldwell, Pleasant Hill, CA. D. S. Parker.

### Waste Treatment Processes—Group 5D

Water Engineering and Management WENMD2, Vol. 138, No. 4, p 23-25, April 1991. 1 fig, 2 tab, 8

Descriptors: \*Clarifiers, \*Sanitary engineering, \*Wastewater treatment facilities, Biological wastewater treatment, Circular clarifiers, Comparison studies, Design criteria, Performance evalua-tion, Rectangular clarifiers. Simulation. Rectangular vater treatment.

In the United States both circular and rectangular clarifiers have been used successfully in biological wastewater treatment applications. In the long run, however, circular clarifiers appear to be more efficient and economical. The author's firm designs a circular clarifier that is 1 to 5 ft deeper than conventional circular or rectangular tanks, allowing some added room for sludge blanket storage during peak flow events. This greater depth allows higher overflow rates before effluent clarity is threatened. The higher overflow rate capability of the circular flocculator-clarifier means that the need for tankage construction is significantly need for tankage construction is significantly lower, resulting in savings of both capital and operating costs. The hydraulic capacity of the larger circular units is higher than the typical large rectangular tank, meaning fewer sets of equipment need to be purchased, operated, and maintained. The circular flocculator-clarifier usually is more adaptable to constrained sites in urban areas beadaptable to constrained sites in urban areas be-cause circles tend to fit into odd-shaped spaces more easily than rectangles do. Given rectangular-shaped sites, circular tanks designed at peak over-flow rates of 1500 gallons/day/sq ft take up about the same amount of room as rectangular units at 1200 gallons/day/sq ft. Recent simulation studies seem to verify existing design guides with regard to clarifier depth, weir position, and allowable overflow rates for circular clarifiers. (See also W91-11223) (Rochester-PTT) W91-11223) (Rochester-PTT) W91-11224

SELECTIVE CONCENTRATION OF LEAD(II) CHLORIDE COMPLEX WITH ANION-EXCHANGE MEMBRANES.

T. Hayashita, R. A. Bartsch, T. Kurosawa, and M.

Analytical Chemistry ANCHAM, Vol. 63, No. 10, p 1023-1027, May 15, 1991. 7 fig, 2 tab, 17 ref.

Descriptors: \*Anion exchange, \*Chlorides, \*Heavy metals, \*Lead, \*Membrane processes, \*Separation techniques, \*Wastewater treatment, Copper, Ion transport, Iron, Nickel, Zinc.

The feasibility of selective heavy metal ion separa-The reasoning of selective neavy metal for separa-tion by liquid membrane transport processes for wastewater treatment in hydrometallurgical proc-essing was studied with lipophilic tetraalkylam-monium ions as carriers for heavy metal chloride complexes. Selective transport of lead(II) over cadmium(II) chloride complexes through a bulk chloroform membrane that contains tetraheptylammonium ions as the carrier for metal chloride com-plexes resulted from slow release of the Cd(II) complex from the organic membrane into the aque-ous receiving phase. For an emulsion liquid memous receiving panse. For an emuision inquia mem-brane transport system in which dimethyldiocty-lammonium bromide functions not only as the liquid anion exchanger but also as the surfactant for emulsion stabilization, good permeation selec-tivity for lead(II) chloride complex over that of Cd(II) and high permeation selectivity over Cu(II), Fe(III), Ni(II), and Zn(II) were achieved. Good Fe(III), N(II), and Zh(II) were achieved. Good selectivity for the concentration of the toxic heavy metal ion species Pb(II) was obtained in both bulk liquid membrane and highly efficient emulsion liquid membrane systems. (Geiger-PTT) W91-11247

DENITRIFICATION BY THERMOPHILIC SOIL BACTERIA WITH ETHANOL AS SUBSTRATE IN A USB REACTOR.
Planta Piloto de Procesos Industriales Microbiolo-

gicos, Tucuman (Argentina).
C. N. Laurino, and F. Sineriz.
Biotechnology Letters BILED3, Vol. 13, No. 4, p. 299-304, April 1991. 2 fig, 3 tab, 16 ref.

Descriptors: \*Biofilm reactors, \*Biological wastewater treatment, \*Denitrification, \*Sludge bed, \*Soil bacteria, \*Wastewater treatment, Bacillus, Biodegradation, Biological treatment, Ethanol, Nitrates, Nitrogen removal.

Thermophilic biological denitrification was studied in a laboratory-upflow sludge blanket reactor fed in a laboratory-upflow sludge blanket reactor fed with ethanol as a carbon and energy source. High denitrification efficiency (>98%) was obtained at an ethanol:nitrate ratio > 2 and at a hydraulic retention time (HRT) of 5 hr. The performance of the system with respect to nitrate removal was very satisfactory (>95%), even at high nitrate (235 mg NO3-N/L) and hydraulic (3 hr HRT) loading rates. A stable sludge was formed by spherical granules 1 to 3 mm in diameter with a content of 25.8 g VS/L and were almost exclusively composed of bacteria belonging to the genus Bacillus. (Author's abstract) (Author's abstract) W91-11254

USE OF A BACKFLUSH TECHNIQUE IN CROSS-FLOW MICROFILTRATION FOR TREATING NATURAL WATER AND FILTER BACKWASH WASTEWATER IN WATER WORKS.
Asian Inst. of Tech., Bangkok (Thailand). Div. of

Environmental Engineering. For primary bibliographic entry see Field 5F. W91-11270

EFFECT OF A CHELATING AGENT (DTPA) ON ANAEROBIC WASTEWATER TREAT-MENT IN AN UPFLOW SLUDGE BLANKET

National Research Council of Canada, Ottawa (Ontario). Inst. for Environmental Chemistry.
K. J. Kennedy, E. Andras, C. M. Elliott, and B.

Canadian Journal of Civil Engineering CJCEB8, Vol. 18, No. 1, p 53-57, February 1991. 4 fig, 1 tab, 11 ref.

Descriptors: \*Biological wastewater treatment, \*Chelating agents, \*Pulp wastes, \*Wastewater treatment, Calcium, Cobalt, Heavy metals, Ions, Iron, Manganese, Nickel, Pentasodium diethylenetriamine pentaac, Performance evaluation, Pulp and pener industry. and paper industry.

Penta sodium dithylene triamine penta acetate (DTPA) is one of the cationic chelating agents used in the manufacture of chemithermomechaniused in the manufacture of chemithermomechanical pulp and thermomechanical pulp. DTPA is added during bleaching to bind metal ions. To ensure a consistent quality pulp, DTPA usually is added in excess, resulting in a residual amount of uncomplexed DTPA in the wastewater stream (about 100 mg/L). Residual DTPA can complex metal ions (e.g., Ni(2+), Ca(2+), Co(2+), and Mn(2+)) that are essential for the anaerobic bacterial growth and granulation. The effect of DTPA nanaerobic granular sludge biomass was examon anaerobic granular sludge biomass was exam-ined. The acetoclastic ability (capacity of the microbial culture to convert acetic acid to methane) was studied using batch anaerobic toxicity assays. Batch and continuous upflow anaerobic sludge bed filter reactor tests indicated that acidogenic and methanogenic activities were relatively unaffected methanogenic activities were relatively unaffected by short-term exposure to DTPA, but that long-term exposure to high concentrations (> 1800 mg/L) to low concentrations (180 mg/L) in the absence of a sacrificial trivalent cation eventually led to inhibition of hydrogen consuming and acetoclas-tic methanogens. An anaerobic sludge bed reactor exposed to DTPA that had been complexed to sacrificial Fe(3+) was not affected. (Rochester-PTT) W91-11277

FERTILITY OF WORKERS CHRONICALLY EXPOSED TO CHEMICALLY CONTAMINATED SEWER WASTES.
Cincinnati Univ., OH. Coll. of Medicine.
G. K. Lemasters, H. Zenick, V. Hertzberg, K. Hansen, and S. Clark.

Reproductive Toxicology REPTED, Vol. 5, No. 1, p 31-37, 1991. 4 tab, 41 ref. March of Dimes Grant 15-60.

Descriptors: \*Epidemiology, \*Fertility, \*Popula-tion exposure, \*Public health, \*Toxicity, \*Wastewater facilities, Chronic effects, Sewer sys-tems, Sublethal effects, Water pollution effects.

A study was conducted to assess fertility in males exposed to mixed industrial and domestic wastes. The workers were employed at a large metropolitan wastewater collection and treatment facility in a highly industrialized city. Eligibility requirements limited the cohort to currently employed, married men under the age of 36 at time of hire, and employed for at least one year at the participating company. A detailed reproductive history was obtained from the wives of 231 employees in order to evaluate fertility. Daily work records were used to define exposure status. To ascertain problems of infertility, the ratios of observed live births to expected live births (generated from US birth probabilities) for exposed and nonexposed groups were calculated, and the ratios of these Standardized Fertility ratios (SRFs) were compared. Other analyses considered the couples' contraceptive history and preexposure versus postexposure experience. Though multiple statistical approaches were used to examine the data, the conclusion of this study was that exposure to chemical proacties were used to examine the data, to calculate of this study was that exposure to chemical mixtures was not associated with a decrease in the couples' fertility. (Author's abstract)

USE OF LIGAND-MODIFIED MICELLAR-EN-HANCED ULTRAFILTRATION IN THE SE-LECTIVE REMOVAL OF METAL IONS FROM

Oklahoma Univ., Norman. Inst. for Applied Surfactant Research.

J. Klepac, D. L. Simmons, R. W. Taylor, J. F. Scamehorn, and S. D. Christian.

Scamentorn, and S. D. Christian.
Separation Science and Technology SSTEDS,
Vol. 26, No. 2, p 165-173, 1991. 5 fig. 1 tab, 18 ref.
National Science Foundation Grant CBT-8814147,
Dept. of Energy Grants DE-FG05-84ER13678 and
DE-FG01-87FE61146, Bureau of Mines Grant
G1125132-4001, and EPA Grant R-817450-01-0.

Descriptors: \*Membrane filters, \*Metal complexes, \*Metal-finishing wastes, \*Metals, \*Separation techniques, \*Ultrafiltration, \*Wastewater treatment, \*Water pollution treatment, Aggregates, Calcium, Copper, Ions, Selectivity, Surfactants.

Ligand-modified micellar-enhanced ultrafiltration (LM-MEUF) is a membrane-based separation technique which can selectively remove specific ions from an aqueous solution containing several ions of like charge. In LM-MEUF, surfactant and ampho-philic ligand are added to the contaminated water. The surfactant forms aggregates called micelles, and the ligand is selected to complex the ion of interest and solubilize strongly in the micelles. The interest and solubilize strongly in the miceles. I are result is micelles containing a high fraction of the ligand and the target ion. If the surfactant is chosen to have the same charge as the target ion, other ions in solution with this same charge will not tons in solution with time same change. While the associate with the micelles, making the retention of ions by the micelles very selective. The solution is then passed through an ultrafiltration membrane with pore sizes small enough to block the passage of micelles. In this study, divalent copper is the target ion in a solution also containing divalent target ion in a solution also containing divalent calcium. A cationic surfactant is used with N-ndodecyl-iminodiacetic acid as the copper-specific ligand. Rejections of copper up to 99.2% are ob-served, with no rejection of calcium, showing that LM-MEUF has almost perfect selectivity, as well Loy-MELUF has almost perfect selectivity, as well as high capacity in this case. This method could be used on wastewaters containing a toxic heavy metal cation with other relatively innocuous cations, such as those produced by metal plating plants. (Author's abstract)

W91-11318

LABORATORY STUDIES OF VIRUS SURVIV-AL DURING AEROBIC AND ANAEROBIC DI-GESTION OF SEWAGE SLUDGE.

Florida Univ., Gainesville. Lab. of Environmental Microbiology.

P. R. Scheuerman, S. R. Farrah, and G. Bitton. Water Research WATRAG, Vol. 25, No. 3, p 241-

### **Group 5D—Waste Treatment Processes**

245, March 1991. 1 fig, 4 tab, 20 ref. U. S. Environmental Protection Agency Grant R806290.

Descriptors: \*Enteroviruses, \*Sludge digestion, \*Sludge disposal, \*Soil amendments, \*Viruses, \*Sludge disposal, \*Soil amendments, \*Viruses, \*Wastewater treatment, \*Water pollution sources, Aerobic conditions, Anaerobic conditions, Cox-sackie virus, Polio, Rotaviruses, Sludge stabilization. Waste disposal

One popular proposal for the disposal of wastewater treatment sludge is the use of the sludge for soil amendments. The potential risks associated with disposing of sludge on soil for groundwater and crop contamination by enteric groundwater and crop contamination by enteric viruses requires better understanding to reduce these risks to acceptable levels. The survival of three enteroviruses (polio 1, coxsackie B3 and echo 1) and a rotavirus (SA-11) was studied under labo-ratory conditions. The effects of temperature, dissolved oxygen, detention time, sludge source and virus type on virus inactivation were determined. Temperature was the single most important factor influencing the rate of virus inactivation. No significant differences were found for virus inactivation rates at dissolved oxygen levels between 0.9 and 5.8 mg/L. However, the inactivation rate of the viruses under aerobic conditions was significantly greater than the inactivation rate under anaerobic conditions. This suggests that different factors are influencing virus survival under aerobic and anaer-obic conditions. It is possible that components of aerobic digestion accelerate virus inactivation and/ or components of anaerobic digestion such as detergents protect viruses from inactivation. Sludge source, detention time and virus type did not significantly influence the rate of virus inactivation. (Doyle-PTT) W91-11319

MODELING THE UPFLOW ANAEROBIC SLUDGE BED-FILTER SYSTEM: A CASE WITH HYSTERESIS.

Biotechnology Research Inst., Montreal (Quebec). S. R. Guiot. Water Research WATRAG, Vol. 25, No. 3, p 251-262, March 1991. 7 fig, 4 tab, 34 ref.

Descriptors: \*Activated sludge process, \*Anaerobic digestion, \*Model studies, \*Wastewater treatment, Chemical oxygen demand, Filter media, Hydrogen ion concentration, Hysteresis, Kinetics, Mathematical models, Retention time.

A hybrid upflow sludge bed-filter (UBF) anaerobic reactor was successfully used for treatment of synthetic soluble 1% sugar waste. Anaerobic digestion of organic wastes is sequentially processed by different groups of bacteria including acidogens, acctogens and methanogens: the product of one group being the substrate for another group. However, some models validate digestion as a single one population system. The acetoclastic methanogenipopulation system. The accroclastic methanogemiss is the rate limiting step, in balanced anaerobic digestion of carbohydrates. Using mass balances around the system, a UBF system under constant operational conditions can be described in statespace equations which give predictions of efficiency rates for methane production as a function of the hydraulic residence time, biomass concentration and influent concentration. An hysteresis ph nomenon was observed with respect to changes in nomenon was observed with respect to changes in acidogenic/acetoclastic specific activities ratio. The Haldane equation was adapted for predicting performance inhibition by undissociated volatile fatty acids as a function of substrate-COD and pH. The Monod and adapted Haldane models were solved simultaneously with substrate mass balance of a UBF reactor. The soluble COD removal efficiency of the property of the control of ciency and methane productivity were predicted as a function of the dilution rate. Critical values of solid and hydraulic residence times were also esti-mated. (Doyle-PTT) W91-11321

COLOUR REMOVAL FROM TEXTILE EF-FLUENTS BY ADSORPTION TECHNIQUES. Minya Univ. (Egypt). Dept. of Chemical Engi-

M. S. El-Geundi. Water Research WATRAG, Vol. 25, No. 3, p 271-

273, March 1991, 4 fig. 2 tab. 4 ref.

Descriptors: \*Adsorption, \*Color removal, \*Dye industry wastes, \*Industrial wastewater, industry wastes, \*Industrial wastewater, \*Wastewater treatment, Adsorbents, Adsorption kinetics, Corn, Egypt, Textile mill wastes.

The treatment of aqueous effluents in countries in the Middle and Far East is extremely important as an means of conserving and recycling water. The rapidly growing textile industries in these areas produce large quantities of effluent, but conventional adsorption systems which use activated carbon are expensive and require regeneration. In Egypt, a vast amount of maize cob is available as an agricultural waste. The maize cob plus adsorbed dye could be burned as much of it is used as a fuel already. The adsorption of two basic dyestuffs (Astrazon Blue and Maxilon Red) and two acid dyestuffs (Telon Blue and Erionyl Red) into maize dyestuffs (1eion Blue and Erionyl Red) into mazze cob was studied. High adsorptive capacities were observed for the adsorption of the basic dyestuffs, namely 160 and 94.5 mg dye per g maize cob for Astrazon Blue and Maxilon Red, respectively. Lower capacities were obtained with the acid dyestuffs, namely 47.7 and 41.4 mg per g maize cob for Erionyl Red and Telon Blue, respectively. The structure of the maize cob is cellulose based, and the surface of cellulose in contact with water is negatively charged. Thus acidic dyes suffer a coulombic repulsion due to the presence of anionic groups in maize cob structure. Basic dyes, on the other hand, are attracted approaching the maize cob structure. A series of contact-time experiments was undertaken in an agitated batch absorber to assess the effect of the system variables, namely, agitation speed, maize cob particle size and maize cob mass. The data show that increasing the rate of agitation and the mass of maize cob increases the rate of dye adsorption, while increasing the parti-cle size decreases adsorption rate. (Doyle-PTT)

1-NAPHTHALENESULFONIC ACID AND SUL-1-NAPHTHALENESULFUNIC ACID AND SULFATE AS SULFUR SOURCES FOR THE GREEN ALGA SCENEDESMUS OBLIQUUS. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. füer Biotechnologie. M. Luther, and C. J. Soeder. Water Research WATRAG, Vol. 25, No. 3, p 299-307, March 1991. 11 fig. 5 tab, 38 ref.

Descriptors: \*Algae, \*Biological wastewater treat-ment, \*Detergents, \*Dyes, \*Scenedesmus, \*Sulfur, \*Wastewater treatment, Biomass, Carbon radioiso-topes, Chlorophyta, Radioactive tracers, Water

Naphthalene sulfonic acids, manufactured as pre-products for detergents and textile dyes, have been classified as persistent xenobiotics that can pass wastewater treatment plants without significant biodegradation. It is of scientific and practical interest to find biotechnological ways to degrade these materials in the effluents of factories producing these compounds. The green alga Scenedesmus obliquus was grown in batch cultures either with sulfate or 1-naphthalenesulfonic acid (1-NS) or both compounds as sulfur source. Growth rates of the sulfur compounds were dependent on the initial concentrations of the sulfur sources (Ks-value for sulfate = 9.9 micro moles; Ks-value for 1-NS for sulfate = 9.9 micro moles; Ks-value for 1-NS = 46 micromoles). Threshold concentrations for uptake were 6.3 micromoles for sulfate and 38.2 micromoles for 1-NS. When 0.014-0.140 micromoles of sulfate were added to the medium containing 0.217 micromoles of 1-NS, the amount of 1-NS eliminated after 5 d was reduced in proportion to the sulfate dosage. The calculated sulfur elimination rates and those obtained using S-35 labeled compounds agreed with one another to a large nation rates and those obtained using 5-3 labeled compounds agreed with one another to a large extent. The carbon of C-14 labeled 1-NS did not accumulate in the biomass. When cultivating Scenedesmus obliquus with sulfate and 1-NS as sulfur sources in a turbidostat the maximum growth rate. of Scenedesmus obliquus was 1 micron/0.107 h with sulfate at a preset biomass concentration of 85 mg dm/L and a maximal elimination of about 70% mg dm/L and a maximal enimanation of about 0'w was determined at a biomass concentration of 1510 mg dm/L. Growth and elimination rate were re-duced when 1-NS elimination reached 14%. Addi-tional batch experiments showed that small

amounts of sulfate had a great influence on growth and on elimination of 1-NS. Pulse addition of sulfate to a continuous culture with 1-NS as sulfur source increased the growth rate 20 times and the elimination rate of 1-NS 15 times. (Doyle-PTT) W91-11326

FOAMING IN ACTIVATED SLUDGE PLANTS: A SURVEY IN QUEENSLAND, AUSTRALIA AND AN EVALUATION OF SOME CONTROL

Queensland Univ., Brisbane (Australia). Dept. of Microbiology.
L. L. Blackall, A. E. Harbers, P. F. Greenfield,

and A. C. Hayward.
Water Research WATRAG, Vol. 25, No. 3, p 313-317, March 1991. 2 fig, 3 tab, 31 ref.

Descriptors: \*Activated sludge process, \*Foaming, \*Wastewater facilities, \*Wastewater treatment, Actinomyces, Australia, Evaluation.

Activated sludge sewage treatment plants that were affected by biological foams attributed to the presence of actinomycetes were surveyed in Queensland, Australia. Nocardia amarae and Nocardia pinensis were the predominant organisms found to accumulate selectively in the foam phase. found to accumulate selectively in the foam phase. Foaming was shown to be a significant problem in Queensland with 92% of surveyed plants being affected. A total of 60% of these plants suffered from bulking, however, no correlation between these two problems was noted. No operational, design, influent or weather feature was found to be consistent in all foaming plants. Apart from the fact that the plants were all variations of the activated sludge process, the only other aspect shared by them was that large numbers of filamentous bacteria were present in the foam. Field scale trials were occulted to evaluate control strategies bacteria were present in the foam. Field scale trials were conducted to evaluate control strategies against actinomycete foaming or scumming in activated sludge plants. The effects were assessed of altering the rate of return activated sludge recycle, dosing of the aeration tank with anaerobic digester products, the addition of a commercial product specifically designed to control foaming, altering studge age, varying levels of mixed liquor suspended solids (MLSS) and altering other operational features. These strategies did not effectively con-trol scumming in activated sludge, however, some operational features, such as location of aerators and liquid surface turbulence were highlighted as exacerbating the problem. (Author's abstract)

ELECTROLYTIC MODEL SYSTEM FOR REDUCTIVE DEHALOGENATION IN AQUEOUS ENVIRONMENTS.

W91-11328

Stanford Univ., CA. Dept. of Environmental Engineering. For primary bibliographic entry see Field 5B. W91-11343

ABBEYSTEAD OUTFALL WORKS: BACK-GROUND TO REPAIRS AND MODIFICA-TIONS AND LESSONS LEARNED.

TIONS AND LESSONS LEARNED.
W. E. Orr, A. M. Wood, J. L. Beaver, R. J.
Ireland, and D. P. Beagley.
Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 5, No. 1, p. 720, February 1991. 9 fig. 9 ref.

Descriptors: \*Conjunctive use, \*Explosions, \*Methane, \*Outfall, \*Tunnels, Accidents, Design criteria, Maintenance, Safety.

When an explosion occurred in the Abbeystead valve house of the Lancashire Conjunctive Use Scheme causing injuries and loss of life, an inde-pendent investigation of the accident and repairs pendent investigation of the accident and repairs and modifications to the scheme were carried out. The cause of the explosion was determined to be ignition of a mixture of methane and air that had accumulated in the wet room of the valve house. The methane had been displaced from a void that had formed in the Abbeystead end of the Wyresdale tunnel during a period of 17 days before the explosion when no water was pumped through the system. When pumping of water was resumed, the

### Waste Treatment Processes—Group 5D

water level in the tunnel rose slowly and pushed out the methane and air mixture in the void through the air valves near the end of the tunnel. The void in the tunnel was produced by loss of water through a wash-out valve at the outfall, which had been left permanently cracked open to minimize silt accumulation in the dead end of the minimize silt accumulation in the dead end of the tunnel beyond the valve house. After several options were studied, the following modifications to the conjunctive scheme were selected to ensure the future safety of the facility: a new vent outlet on the main tunnel to discharge free gas before it reaches the valve house; pipework to pass any vented gas to the valve house wet room to be discharged at roof level through open vent stacks; reconstruction of the valve house with a new concrete roof over the dry room; a mesh roof over the wet room permitting free ventilation; replaceconcrete roof over the dry room; a mesh roof over the wet room permitting free ventilation; replace-ment of all other existing air valves in the wet room by open vent stacks discharging at roof level; and construction of a dry moat around the periph-ery of the valve house for safety and security purposes. In addition the wet room is to be kept free of all electrical wiring and equipment and the circulation system for the dead-end branch of the tunnel will be improved. (Geiger-PTT)

APPLICATION OF PHYSICOCHEMICAL TREATMENT TO AN OVERLOADED SEWAGE WORKS.
K. Jones, D. E. Smith, and C. Thomas.
Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 5, No. 1, p 28-35, February 1991. 10 fig, 4 tab, 9 ref.

Descriptors: \*Biological wastewater treatment, \*Physicochemical treatment, \*Wastewater treatment, Aluminum sulfate, Biochemical oxygen demand, Cost-benefit analysis, Lime, Phosphate removal, Polyelectrolytes, Sedimentation.

Two methods of physicochemical treatment were applied to a wastewater treatment works to relieve organic overloading on biological processes and improve effluent quality. The Clariflow system was retrofitted to the existing works in parallel with the two primary sedimentation tanks and provided additional sedimentation with Clarifloc EF (a lime-based slurry) and commercial alumnum suffer. An in-house system of design commercial and the provided additional sedimentation with Clarifloc EF (a lime-based slurry) and commercial aluminum sulfate. An in-house system of dosing coagulant and coagulant aid into existing tanks was tried using Zetag 92, a cationic polyacrylamide at 1 mg/L and aluminum sulfate at 400 ml product per cu m sewage (equivalent to 19.5 mg/L as A13+). Both Clariflow and straight chemical addition increased the efficiency of primary sedimentation, thereby reducing the load applied to biological filters and improving final effluent quality. The Clariflow process removed 31-65% of the BOD entering the tank, while straight chemical addition removed 26-50%. Values for suspended solids were 69-85% and 53-84%, respectively. Cost-benefit studies suggested that a chemical cost of 2-3 pounds/cu m was optimum for the Clariflow process, while about 3-5 pounds/cu m gave the best result for straight chemical addition. PH values ranging from 8.1 to 9.2 in the sewage from the Clariflow plant applied to the biological filters had no adverse effect on their performance. The Clariflow process was operated under almost constant flow conditions, while the straight chemical addition work was subject to normal diurnal flow variations. (Geiger-PTT)

# COMPARISON OF ALTERNATIVE OPERAT-ING MODES ON THE HALIFAX ACTIVATED-SUUDGE PLANT. Yorkshire Water Authority (England).

G. A. Jon

Journal of the Institution of Water and Environ-mental Management JIWMEZ, Vol. 5, No. 1, p 43-50, February 1991. 5 fig, 7 tab, 2 ref.

Descriptors: \*Activated sludge process, \*Biochemical oxygen demand, \*Wastewater treatment, Aeration, Clarification, Comparison studies, Costs, Hydraulic loading, Settling tanks, Sludge bulking.

The Halifax activated sludge wastewater treatment plants have been operated in the Halifax mode

since 1981. This mode, termed mode 2, uses all four aeration lanes and both final settling tanks and has successfully prevented previous bulking of the activated sludge. Two other operation modes were employed to study operation of the plants under stressed conditions and to improve operation costs. Mode 1 employed conventional treatment using only two of the four aeration lanes, each with a final settling tank. Mode 3 used a modified Halifax mode with a facility to allow sludge to bypass the final settling tank. Mode 1 allowed a high hydraulic loading capacity to be treated satisfactorily with the effluent quality meeting the required standards with Vitox oxygen on demand at an average rate with vitox oxygen on demand at an average rate of slightly over 1 ton/day. However, problems were encountered in containing the mixed liquor blanket within the final settling tanks for short periods at peak flows and the clarifier capacity might be inadequate to deal with the mass of solids received from the exceived ingin be madequate to deal with the mass of solids received from the aeration lanes. Operating in the Halifax mode 2 with Vitox oxygen, BOD loads averaged 2.81 tons/day compared to the rated capacity of the mechanical-aeration equipment of about 2 tons/day. The additional load required provision on demand of 0.54 tons/day Vitox provision on demand of 0.54 tons/day Vitox oxygen. By employing only half the treatment plant during mode 3 of operation it was possible to apply an average BOD load of 4.15 tons/day compared to the approximate rated capacity of 2 tons/day. The Vitox system provided, on demand, an average of 2.19 tons/day oxygen to support the mechanical equipment. An uprated works treating a 65% increase in BOD load would have an increase in cost (for oxygen and electricity) of about 100%. (Geiger-PTT)

#### LIQUID EFFLUENTS: NEW SOLUTIONS TO OLD PROBLEMS.

AEA Technology, Harwell (England). Energy and Environment

Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 5, No. 1, p 51-57, February 1991. 7 fig, 1 tab, 9 ref.

Descriptors: \*Electrochemistry, \*Filtration, \*Industrial wastes, \*Liquid wastes, \*Membrane processes, \*Separation techniques, \*Waste treatment, Dewatering, Effluents, Electrodialysis, Incineration, Ion exchange, Osmosis, Oxidation.

The nuclear industry in collaboration with industrial associations have advanced several technologies that will be useful in the future for the processing of industrial effluents. Membrane processes are finding increasing applications in the waste treatment field for the specific removal of trace compounds. Cross-flow, micro-and ultra-fil-tration can remove finely-divided colloidal materiwhile reverse osmosis can remove dissolved solids, and pervaporation can be used to recover and purify organic solvents. Electrically-enhanced and purify organic solvents. Electrically-enhanced filtration processes have been used to control fouling of membranes and maintain a high permeation rate. Electrically conductive micro-and ultra-filtration membranes have cross-flow conditions through the periodic application of short current pulses generating gas bubbles which remove the superficial fouling layer. Electro-osmotic dewatering is attractive for the stream concentrations of intermediate solids content during sludge thickening. Electrochemical processes with the potential for liquid effluent treatment include: electrically enhanced ion-exchange processes, electrochemical tor neural treatment include: electrically enhanced ion-exchange processes, electrochemical ion-exchange methods, ion-exchange/electrodialysis hybrid techniques, and Harwell electrochemical ion-exchange processes for concentrating non-ferrous metals for later recovery by conventional plating methods. Oxidation-reduction reactions find a curvature of amplications is host increasing and plating methods. Oxidation-reduction reactions find a number of applications in both inorganic and organic systems. Effective removal of toxic, electroactive species can be brought about via redox reactions at the electrode/electrolyte interface. Chemical oxidation is an alternative route to incining the destruction of organic compounds. eration for the destruction of organic compounds. Wet oxidation breaks down organic materials to carbon dioxide and water in a process analogous to incineration. Electrochemical incineration uses a highly oxidizing form of silver to effect the destruction of organic compounds in a nitric acid medium. (Geiger-PTT)

W91-11360

### DESIGN OF SEWAGE-TREATMENT PLANTS IN BRISBANE, AUSTRALIA.

M. L. Lever.

Journal of the Institution of Water and Environ-mental Management JIWMEZ, Vol. 5, No. 1, p 58-65, February 1991. 6 fig.

Descriptors: \*Activated sludge process, \*Advanced wastewater treatment, \*Australia, \*Nitrogen removal, \*Organic loading, \*Wastewater treatment, Aeration, Cost analysis, Design criteria, Performance evaluation, Sludge dewatering, Sludge digestion, Sludge thickening.

Brisbane City Council provides sewage-treatment facilities for a population of 800,000, together with industrial effluents having an organic loading equivalent to a further 600,000 people. Three rojects are described to illustrate some of the ifferent designs and operating parameters used in different designs and operating parameters used in Brisbane, where the sewage temperature ranges from 18 to 29 C and stormwater is collected sepa-rately. The first project is a 400,000 population equivalent augmentation to a conventional activat-ed-sludge plant located at Luggage Point. The Luggage Point plant utilizes preliminary treatment, primary treatment, an activated-sludge process, sludge thickening, and sludge digestion, drying, and dewatering under an automatic control and monitoring system. The two other plants, the monitoring system. The two other plants, the Gibson Island and the Wacol sewage treatment Ordinary and the waron sewage treatment plants have to comply, among other standards, with an effluent standard of 10 mg/L for total nitrogen. This requirement, together with site constraints and an economic evaluation of alternatives, resulted in the selection of the extended-aeration process incorporating anoxic zones and separate mixing and aeration. These contemporary designs are specific to Brisbane conditions, and are intend-ed to facilitate reliable operation while being cost effective. (Author's abstract) W91-11361

### STUDY ON TRIPLE-MEMBRANE-SEPARA-TOR (TMS) PROCESS TO TREAT AQUEOUS EFFLUENTS CONTAINING URANIUM.

Institute of Nuclear Energy Research, Lung-Tan (Taiwan).

M. L. Chu, C. P. Tung, and M. C. Shieh. Separation Science and Technology SSTEDS, Vol. 25, No. 13/15, p 1339-1348, 1990. 8 fig, 1 tab,

Descriptors: \*Filtration, \*Liquid wastes, \*Membrane processes, \*Reverse osmosis, \*Uranium. \*Wastewater treatment, Effluents, Fluorides, Microfiltration, Separation techniques, Ultrafiltration.

An effective process incorporated with the novel membrane separation technology was developed to recover uranium from the filtrate effluent of uranium dioxide conversion processes. The prominent feature of the process is that it utilizes separation reature of the process is that it utilizes separation characteristics of three different types of membranes as follow: separation of uranium species from effluent of high fluoride content by ultrafiltration membrane, separation of uranium species from effluent of low fluoride content by reverse room effluent of flow indone content by reversions osmosis membrane, precipitation of uranium species with hydrogen peroxide, and filtration of uranium bearing precipitates by microfiltration membrane. The process is simple and feasible for treatment of liquid waste containing both soluble and suspended uranium species. The recovery of urani-um can reach 95% and the treated effluents meet the current environmental standards. (Author's abstract) W91-11367

### REMOVAL OF HEAVY METALS AND OTHER CATIONS FROM WASTEWATER USING ZEO-LITES.

Bureau of Mines, Reno, NV. Reno Research

Center M. J. Zamzow, B. R. Eichbaum, K. R. Sandgren,

and D. E. Shanks.
Separation Science and Technology SSTEDS,

### Group 5D—Waste Treatment Processes

Vol. 25, No. 13/15, p 1555-1569, 1990. 3 fig, 11 tab,

Descriptors: \*Cleanup operations, \*Heavy metals, \*Mine wastes, \*Wastewater treatment, \*Zeolites, Absorption, Cation exchange, Clay minerals, Ion

Zeolites from abundant natural deposits were investigated by the Bureau of Mines for efficiently cleaning up mining industry wastewaters. Twenty-two zeolites were analyzed by X-ray diffraction and inductively coupled plasma analysis (ICP). These included clinoptilolite, mordenite, chabazite, erionite, and phillipsite. The zeolites were primari-ly in the sodium or calcium form, but potassium and magnesium counter ions were also present. Bulk densities of a sized fraction (minus 40, plus 65 mesh) varied from 0.48 to 0.93 g/ml. Heavy metal mesh) varied from 0.48 to 0.93 g/ml. Heavy metal ion exchange loading values on two clinoptilolites ranged from 1.6 milliequivalents/g for lead to 0.00 milliequivalents/g for mercury in single ion tests. The selectivity series was determined to be Pb>Cd>Cb>Cu(II)>Co(II)>Cr(III)>Zn>N (III)>Hg(II). Sodium was the most effective exchangeable ion for ion exchange of heavy metals. Wastewater from an abandoned copper mine in Nevada was used to test the effectiveness of clinetical for treating a multi-ion wastewater. Alternative for the state of the control of t optilolite for treating a multi-ion wastewater. Aluminum, Fe(III), Cu(II), and Zn in the copper mine minum, Fe(III), Cu(II), and Zn in the copper mine wastewater were removed to below drinking water standards, but Mn(II) and Ni(II) were not. Calcium and NH4 were absorbed preferentially to all heavy metals were eluted from zeolites with 3% NaCl solution. Heavy metals were concentrated in the eluates up to 30-fold relative to the waste solution. Anions were not adsorbed by the zeolites. (Au-Anions were not adsorbed by the zeolites. (Author's abstract) W91-11369

TREATMENT OF WASTE WATER FROM WET LIME(STONE) FLUE GAS DESULFURIZA-TION PLANTS WITH AID OF CROSSFLOW MICROFILTRATION.

Utrechtseweg 310, 6812 AR Arnhem, The Nether-

Janos.
G. D. Enoch, W. Spiering, P. Tigchelaar, J. De Niet, and J. B. Lefers. Separation Science and Technology SSTEDS, Vol. 23, No. 13/15, p 1587-1605, 1990. 9 fig, 5 tab,

Descriptors: \*Desulfurization, \*Heavy metals, \*Industrial wastes, \*Limestone, \*Microfiltration, \*Wastewater treatment, Arsenic, Cadmium, Chromium, Copper, Fouling, Lead, Membrane processes, Mercury, Nickel, Selenium, Sulfides, Zinc.

A treatment method was developed to remove heavy metals such as As, Cd, Cr, Cu, Hg, Ni, Pb, Se and Zn very efficiently from wastewater from wet limestone-gypsum flue gas desulfurization plants (FGD). This method was based on coprecipation of heavy metal bydroxides and sulfides plants (PGD). Into method was based on coprecipitation of heavy metal hydroxides and sulfides followed by crossflow microfiltration as a post-treatment. The experiments were carried out on pilot plant scale with actual wastewater from a FGD plant downstream of a coal fired boiler. The effect of membrane fouling as a function of several process parameters was investigated. From scanprocess parameters was investigated. From scaning electron microscopy-energy dispersive spectroscopy analysis it was found that the fouling layer on the membrane surface consisted mainly of gypsum and Mg., Al., Si., and Fe-compounds. Membrane fouling could be decreased by periodic backwashing and by increasing the liquid velocity in the membranes. Moreover, a computer controlled start up procedure of the crossflow microfiltration unit was developed to minimize the effect membranes fouling and to increase the operator to compute the control of membranes fouling and to increase the operator to compute the control of membranes fouling and to increase the operator to control of membranes fouling and to increase the operator to control of the control of membranes fouling and to increase the operator to control of the control nitration unit was developed to minimize the effect of membrane fouling and to increase the operating time before chemical cleaning of the membranes is necessary. The developed chemical cleaning was very successful because it was possible to achieve the initial permeate flux after each experiment. (Author's abstract)

W91-11371

SYNTHESIS AND DECOMPOSITION OF NOVEL ORGANOPHOSPHORUS COMPLEX-

Argonne National Lab., IL. Chemistry Div. R. C. Gatrone, E. P. Horwitz, P. G. Rickert, and K. L. Nash.

Separation Science and Technology SSTEDS, Vol. 25, No. 13/15, p 1607-1627, 1990. 1 fig, 4 tab, 16 ref.

Descriptors: \*Chemical recovery, \*Industrial wastes, \*Nuclear wastes, \*Organic acids, \*Separation techniques, \*Wastewater treatment, Cleanup operations, Metal complexes, Organophosphorus compounds.

During an on-going investigation of the aqueous complexation chemistry of transition metals, lanth-anides, and actinides found in nuclear waste; aqueous soluble organic diphosphonic acids were synthesized as aids in the extraction/recovery of metals from nuclear waste, groundwater, or hydrometallurgical processes. The reagents form aqueous soluble complexes at very low pH values (< 1). After use, these compounds do not represent After use, these compounds do not represent an additional waste management problem as they are readily decomposed to innocuous materials (phosphoric acid and carbon dioxide) by warming and/or by the action of a mild oxidizing agent. (Geiger-PTT) W91-11372

BIODEGRADATION OF BENZENE AND A BTX MIXTURE USING IMMOBILIZED ACTI-VATED SLUDGE

w Jersey Inst. of Tech., Newark. Biotechnology

M. Lodaya, F. Lakhwala, E. Rus, M. Singh, and G. Lewandowski.

Journal of Environmental Science and Health (A) JESEDU, Vol. 26, No. 1, p 121-137, 1991. 6 fig, 4 tab, 21 ref.

Descriptors: "Activated sludge, "Aromatic compounds, "Benzene, "Biodegradation, "Biological wastewater treatment, "Wastewater treatment, Aerobic bacteria, Kinetics, Microbial degradation, Model studies, Oxygenation.

Immobilized cell reactors may offer several advantages over free-cell systems in the treatment of hazardous and toxic wastes. Besides reducing biomass washout in continuous reactors, immobiliza-tion facilitates biomass separation from the process stream. Immobilized cells may also be more resist-ant to higher concentrations of toxic species and cell concentrations can be much higher. This last feature can result in higher efficiencies due to increased biodegradation rates per unit of reactor volume. Aerobic biodegradation was studied using activated sludge immobilized in calcium alginate gel. Hydrogen peroxide provided the dissolved oxygen source in a recirculation reactor that was oxygen source in a recirculation reactor that was operated batchwise and continuously. Responses to changes in benzene concentrations, flow rates, and biomass loadings were measured. Sixty percent of the benzene was biologically degraded in batch tests after 24 h using an initial concentration of 100 mg/L. A residence time of 17.14 h was required to biologically reduce heavener concentrations from biologically reduce benzene concentrations from 600 ppm to below the detection limit (1 ppm) during continuous operation. The system was mod-eled using Monod kinetics for substrate utilization. The apparent mg/L/h values changed with biomass loadings, but were independent of initial ben-zene concentrations. The aromatic species in BTX mixtures (i.e. benzene, toluene and o-, m-, and p-xylene) can all be degraded at the same time. (Doyle-PTT) W91-11381

ACTIVATED SLUDGE PROCESS TO REDUCE THE POLLUTION LOAD OF A DYE-INDUS-

MAN TABLE. MANAGEMENT ASSOCIATION FOR HELDRICH ASSOCIATION FOR MICROBIOLOGY. P. Kanekar, and S. Sarnaik. Environmental Pollution ENPOEK, Vol. 70, No. 1, p 27-33, 1991. 3 tab, 12 ref.

Descriptors: \*Activated sludge process, \*Dye industry wastes, \*India, \*Wastewater treatment, Activated sludge, Bacteria, Biological treatment, Biological wastewater treatment, Cattle, Chemical

oxygen demand, Color removal, Dyes, Effluents, Feces, Nitrogen, Organic carbon, Phenols, Pseudo-monas, Sludge digestion, Water quality standards.

A laboratory-scale activated sludge process was developed to reduce the pollution load of a dye-industry waste containing aniline, phenol, methyl violet, and rhodamine B as its major components. The waste, collected from a factory near Pune (India), had an organic load of 5,576 mg/L as the chemical oxygen demand (COD) 896 mg/L as total organic carbon (TOC), and a phenol content of 31.5 mg/L. A microbial sludge capable of growing on the waste was developed from cattle dung and used as a bioinoculum for the process. This resulted in reductions of 60% in COD, 37% in TOC, and 92% in phenol content, and a decrease in optical density from an initial 0.915 to 0.360 at 580 nm. Microorganisms isolated from the sludge were identified as Pseudomonas alcaligenes and P. mendocina. Although treated effluents did not reach the standards prescribed by the Water Pollu-tion Control Board, these studies indicate the feasition Control Board, these studies indicate the feasi-bility of a microbial process to reduce the pollution load of dye-industry waste. As appropriate con-trols were run and the experimental values of reduction in COD, TOC, ammoniacal nitrogen, and phenol were estimated against control values, it became apparent that the observed reduction in organic load from the experimental set was due to microbial activity, and cannot be attributed to mere aeration or volatilization. (Doria-PTT)

SEWAGE TREATMENT WITH PLANTS.

Bath Univ. (England). School of Biological Sci-

R. F. Stott, and S. J. L. Wright. Letters in Applied Microbiology LAMIE7, Vol. 12, No. 4, p 99-105, April 1991. 36 ref.

Descriptors: \*Aquatic plants, \*Artificial wetland treatment, \*Literature review, \*Wastewater treatment, \*Wetland waste treatment, Filtration, Adsorption, Biodegradation, Desorption, Duckweed, Filtration, Floating plants, Hydraulic conductivity, Infiltration, Marshes, Phragmites, Reeds, Roots, Water hyacinth.

The potential of reed beds and similar wetland systems for providing cost-effective wastewater treatment for small, often isolated communities has treatment for small, often isolated communities has led to over 400 such systems being operated or tested in Europe alone. The Max Planck Institute Process (MPIP) evolved through work on the ability of higher plants to tolerate, adapt to, and eliminate water contamination. The current design includes a module of 7 concrete filter trenches in includes a module of 7 concrete filter trenches in which an underdrain is overlain with gravel topped with sand, the whole planted with Phragmites and fed with screened wastewater. The Leystad or marsh pond process evolved from the MPIP to avoid problems of filter trench clogging. The infiltration pond system comprises a preliminary settling/distribution ditch and four infiltration ponds; the system is believed to function by advention, description, descri ponds; the system is believed to function by ad-sorption-desorption, chemical processes involving precipitation and dissolving, and microbial degra-dation and conversion. The method of rock-aquat-ic plant filters combines the use of microbially colonized rock filters and the ability of aquatic plants to enhance sewage treatment. Microbial degradation of organics produces metabolites that can be absorbed by the plant. The root zone method uses Phragmites improve the hydraulic conductivity of the soil bed and create an active soil structure through root and rhizome growth. Floating emergent aquatic plant systems include water hyacinth and duckweed systems. (Doria-PTT) W91-11466

### FOREST INDUSTRY WASTEWATERS.

Proceedings of the International Association on Water Pollution Research and Control symposium held in Tampere, Finland, 5-8 June 1990. Water Science and Technology WSTED4, Vol. 24, No. 3/4, 1991. 447p. Edited by J. Puhakka, J. Rintala, J. Wartiovaara, and P. Heinonen.

### Waste Treatment Processes—Group 5D

Descriptors: \*Industrial wastewater, \*Path of pollutants, \*Pulp and paper industry, \*Pulp wastes, \*Symposium, \*Wastewater treatment, \*Water pollution control, Biodegradation, Chlorinated hydrocarbons, Environmental effects, Pollutant identification, Toxicity, Water pollution effects.

The Third International Symposium on Forest Industry Wastewaters was aimed at bringing together industrialists, scientists, authorities, consultants and contractors worldwide to introduce the latest and contractors worldwide to introduce the latest innovations in pulp and paper industry water pollution control and to discuss the environmental effects of the industry's effluents. Forty-five technical and 10 environmental papers, together with 22 posters, were presented. In the symposium special interest was focused on slowly biodegradable compounds and nutrients. The occurrence, biode-gradability and environmental effects of toxic xenobiotic and wood-derived pulp and paper industry wastewater constituents such as chlorinated phenowastewater constituents such as chlorinated phenolic compounds were of primary concern. Nutrient-balanced biological effluent treatment was examined for its relationship to the overall organic removal efficiency, operation costs, and the environment. (See W91-11468 thru W91-11513) (Wetz-PTT) W91-11467

PROCESS INTERNAL MEASURES TO REDUCE PULP MILL POLLUTION LOAD. Helsinki Univ. of Technology, Espoo (Finland). For primary bibliographic entry see Field 5G. W91-11473

EFFECTS OF CHLORINATION CONDITIONS ON THE AOX AND CHLORINATED PHENOL CONTENT OF KRAFT BLEACH PLANT WASTEWATERS.

P. N. McFarlane, R. W. Allison, T. A. Clark, and K. L. Mackie.

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 55-63, 1991. 14 fig, 2 tab, 16 ref.

Descriptors: \*Bleaching wastes, \*Chlorinated hydrocarbons, \*Chlorination, \*Pulp and paper industry, \*Pulp wastes, \*Wastewater treatment, \*Water pollution control, Industrial wastes, Kraft mills, Model studies, Phenols, Water quality control.

A central composite experimental design was used to develop models of the yields of adsorbable organic halide and chlorophenolic compounds in wastewaters produced by bleaching oxygen delignified kraft pulps. The following five variables were used to control the bleaching conditions: total available chlorine, chlorine dioxide substitution, incoming kappa number, chlorination time and temperatures. The total available chlorine and the chlorine dioxide substitution were the most important parameters in all the models developed. important parameters in all the models developed. The yields of adsorbable organic halide and total The yields of ausoroanic organic nature and total chlorophenolic compounds increased linearly with increasing total chlorine application. Elevating the level of chlorine dioxide substitution caused the yield of adsorbable organic halide to decrease linearly while the yield of total chlorophenols diminished in a nonlinear manner. Increasing the level of shoring dispute whether the control of th chlorine dioxide substitution at a given total chlorine application is an effective means of reducing the emissions of both adsorbable organic halide and chlorinated phenols. (See also W91-11467) and chlorinated phenols. (See also (Author's abstract)
W91-11474

CLOSING PAPER MILL WHITEWATER CIR-CUITS BY INSERTING AN ANAEROBIC STAGE WITH SUBSEQUENT TREATMENT. Papiertechnische Stiftung fuer Forschung und Ausbildung in Papiererzeugung und -Verarbeitung, Munich (Germany, F.R.). Wasser- und Abwasser-For primary bibliographic entry see Field 5G. W91-11477

FUTURE PERSPECTIVES FOR THE ANAERO-BIC TREATMENT OF FOREST INDUSTRY WASTEWATERS.

Agricultural Univ., Wageningen (Netherlands). Dept. of Water Pollution Control.
G. Lettinga, J. A. Field, R. Sierra-Alverez, J. B. van Lier, and J. Rintala.
Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 91-102, 1991. 2 fig, 1 tab, 101 ref.

Descriptors: \*Anaerobic digestion, \*Pulp and paper industry, \*Pulp wastes, \*Sulfite liquors, \*Wastewater treatment, \*Water pollution control, Hazardous wastes, Industrial wastes, Lignin, Sulfur, Temperature effects, Toxicity.

Anaerobic treatment systems have been successful-ly applied over the last decade for combating wastewater pollution loads in the forest industry. However, anaerobic treatment of certain paper mill waste streams is limited by the presence of toxic and recalcitrant organic compounds, high concentrations of sulfur and in some cases high tewater temperatures. Anaerobic treatment is wastewater temperatures. Anaerobic realment is highly effective for waste streams composed mostly of readily biodegradable organic matter, such as thermomechanical pulping effluents and condensates. Moreover, the time is approaching rapidly in which the anaerobic treatment method is rapidly in which the anaerobic treatment method is becoming applicable to the category of difficult forest industry wastewaters. Toxic wastewaters contain large fractions of recalcitrant lignin. Dilution to subtoxic levels should be applied, as well as careful start-up procedures for the maximum adaption of anaerobic microorganisms. If this is not feasible, adsorption, precipitation or oxidation of organic toxins may be applied. Anaerobic treatment can also be applied as an essential part of an integrated treatment resource preservation system. For forest industry wastewater, sulfate and sulfite reduction during anaerobic digestion can be comror rotest industry wastewater, suitate and suffice reduction during anaerobic digestion can be combined with sulfur recovery systems. Biological recovery of elemental sulfur from hydrogen sulfide in anaerobically treated forest industry effluents has promise. The anaerobic method under thermohas promise. The anaerobic method under thermo-philic conditions offers attractive potentials for hot forest industry effluents, permitting the application of higher organic loading rates and eliminating the need for cooling. Recent experiments have shown that the start-up of thermophilic reactors is not so difficult as previously thought. (See also W91-11467) (Mertz-PTT) W91-11478

ANAEROBIC TOXICITY OF FINES IN CHEMI-THERMOMECHANICAL PULP WASTEWAYERS: A BATCH ASSAY-REACTOR STUDY COMPARISON. Water and Earth Science Associates Ltd., Carp

(Ontario).
D. A. Richardson, E. Andras, and K. J. Kennedy.
Water Science and Technology WSTED4, Vol.
24, No. 3/4, p 103-112, 1991. 8 fig. 10 tab, 16 ref.

Descriptors: \*Anaerobic digestion, \*Pulp and paper industry, "Pulp wastes, "Toxicity, "Wastewater analysis, "Wastewater Biodegradability, Chemical analysis, Chemical oxygen demand, Inhibition, Sludge digestion, tewater reactors.

noxicity of chemi-thermomechanical pulping wastewater was tested in batch assays and in anaerobic sludge blanket reactors. In batch serum bottle tests particulate constituent. particulate constituents were responsible for % of the inhibition of acetoclastic activity, and the soluble (fines-free) fraction accounted for 10-20%. Performance of two 2-stage anaerobic sludge blanket reactor systems was compared, one receiving fines-free and the other unaltered chemireceiving intestree and the other unattered chemi-thermomechanical pulping waste for 140 days. Both reactors became acclimatized to chemi-ther-momechanical pulping and developed a tolerance to resin acid concentrations as high as 300-1500 mg/L in the sludge bed. The fines-free reactor was mg/L in the sludge bed. The fines-free reactor was superior throughout, but the differences in performance did not reflect the batch test results. At the organic loading rate of 17-22 g soluble chemical oxygen demand/gvolatile suspended solids/day the fines-free treated 100% chemi-thermomechanical waste with 42% removal efficiency and the unaltered chemi-thermomechanical wastes with 38% removal efficiency. Fines accumulation in the sludge bed of the unaltered waste reactor caused a 70% increase in bed volume, resulted in deteriora-

tion of sludge settleability, and led to an increased likelihood of biomass loss. (See also W91-11467) (Author's abstract)

ANAEROBIC BIODEGRADABILITY AND METHANOGENIC TOXICITY OF PULPING WASTEWATERS.

Agricultural Univ., Wageningen (Netherlands). Dept. of Water Pollution Control. R. Sierra-Alverez, S. Kortekaas, M. van Eekert, and G. Lettinga.

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 113-125, 1991. 5 fig, 5 tab, 57 ref.

Descriptors: "Anaerobic digestion, "Biodegrada-tion, "Methanogenesis, "Pulp and paper industry, "Pulp wastes, "Toxicity, "Wastewater treatment, Chemical oxygen demand, Fatty acids, Lignin, Methane, Methane bacteria.

The effect of various pulping conditions and different lignocellulosic feedstocks on the anaerobic treatability of pulping wastewaters was evaluated. Wastewaters were prepared from lignocellulosic feedstocks commonly used in the forest industry, paraely pine, appure and hirch wood and wheat recastocks commonly used in the forest industry, namely, pine, spruce and birch wood, and wheat straw. The pulping conditions used were representative of those applied in thermomechanical and soda pulping processes. The anaerobic biodegradability and the methanogenic toxicity of the various wastewaters were evaluated in standardized batch bioassays using anaerobic granular sludge. The acidification of the thermomechanical pulping wastawaters (convenience of CIV) wastewaters were non-live for the thermomechanical pulping wastewaters (conversion to CH4 and volatile fatty acids) ranged from 68-87% of the total chemical oxygen demand, indicating their high anaerobic biodegradability. Thermomechanical pulping wastewaters were non-live for the conversion of the c wastewaters were non-toxic to methane bacteria at vastewaters were non-tone to methane outcerns at concentrations expected in paper mill wastewaters. No inhibition was observed at 110 g chemical oxygen demand/L. In contrast, wastewaters preoxygen demand/L. In contrast, wastewaters prepared in alkaline conditions were poorly biodegradable (approximately 50% acidification) and they caused severe inhibition of the methanogenic activity. The 50% inhibitory concentrations ranged from 2.1 to 5.4 g chemical oxygen demand/L. Additional experiments showed that wood resin components, poorly solubilized at acidic to neutral pH, but easily extractable in alkali, are responsible for most of the methanogenic toxicity observed in alkaline pulping wastewaters. These results indicated that contact of wood with alkali contributes significantly to increase the methanogenic toxicity significantly to increase the methanogenic toxicity. significantly to increase the methanogenic toxicity of the pulping wastewater. (See also W91-11467) (Author's abstract)

TREATMENT AND DETOXIFICATION OF AQUEOUS SPRUCE BARK EXTRACTS BY ASPERGILLUS NIGER.

PERGILLUS NIGER.
Agricultural Univ., Wageningen (Netherlands).
Dept. of Water Pollution Control.
J. A. Field, and G. Lettinga.
Water Science and Technology WSTED4, Vol.
24, No. 3/4, p 127-137, 1991. 10 fig, 3 tab, 23 ref.

Descriptors: \*Biological treatment, \*Detoxifica-Descriptors: "Diological treatment, "Detoxinic, on "Fungi, "Pulp and paper industry, "Tannins, "Wastewater treatment, "Wood wastes, Aerobic treatment, Aspergillus, Biodegradation, Hydrogen ion concentration, Toxicity.

Debarking effluents of the forest industry are se-verely toxic waste streams due to their high tannin content. The treatment and detoxification of decontent. The treatment and detoxification of de-barking wastewater with tannin tolerant fungi was investigated. Aspergillus niger was cultivated on aqueous bark extracts and the toxicity was assayed utilizing methanogenic bacteria as the test orga-nism. Sterilized aqueous extracts of spruce bark were diluted to 5.2 g COD/L containing 2.7 g tannin COD/L in either citrate or tartrate buffer and incoulsted with A. niger sprose. During for and inoculated with A. niger spores. During four day aerobic fermentations with citrate buffer, the day aerobic termentations with currate outrer, the elimination of unfiltered COD was 28% and for soluble chemical demand, 63%. The apparent yield of biomass averaged 34% of the extract COD 12% of the extract COD was tannins adsorbed on the ngal biomass. The decrease in the tannin concen-

### **Group 5D—Waste Treatment Processes**

tration was 50%. According to gel chromatogra-phy results, the original oligomeric tannins that resisted biodegradation were those of the highest resisted biodegradation were those of the ingness molecular weight. The toxicity was only partially reduced by the fermentation. During the tartrate buffered fermentations, the pH rose due to the metabolism of the organic acid in the buffer. The rise in pH beyond 6 promoted autoxidative reactions that caused extensive polymerization of the tannins which resisted biodegradation. This resulted not only in an enhanced elimination of the tannins but also in a complete detoxification of the tanniss but also in a complete detoxification of the extracts. Similar levels of detoxification could be obtained in sterile un-inoculated extracts by autoxidation alone (raising the pH and aerating the extracts). Extracts fermented in citrate buffer could be completely detoxified by a subsequent autoxidation treatment. The exclusion peak of the gel chromatograms obtained from the highly autoxidized samples accounted for 53% of the ultraviolet absorbance, whereas no exclusion peak was present in the unoxidized extracts. For the biological treatment and detoxification of the debarking wastewaters, it is recommended that the cultivation of tannin tolerant funit followed by short wastewaters, it is recommended that the cuttiva-tion of tannin tolerant fungi followed by short autoxidation treatments that polymerized the oligo-meric tannin fraction resisting biodegradation to nontoxic high molecular weight polymers. (See also W91-11467) (Author's abstract) W91-11481

EFFECT OF NSSC SPENT LIQUOR ON GRAN-ULE FORMATION AND SPECIFIC MICROBI-AL ACTIVITIES IN UPFLOW ANAEROBIC

REACTORS.
National Research Council of Canada, Montreal (Quebec). Montreal Lab.

S. R. Guiot, L. Lavoir, J. A. Hawari, and R.

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 139-148, 1991. 3 fig, 4 tab, 20 ref.

Descriptors: \*Anaerobic treatment, \*Lignin, \*Pulp and paper industry, \*Pulp wastes, \*Wastewater treatment, Biodegradation, Biomass, Calcium, Chemical oxygen demand, Sludge bed, Sulfite liquors, Suspended solids.

The capability of sulfonated lignin to induce the flocculation of anaerobic sludge in upflow wastewater treatment was evaluated. Two upflow anaerobic sludge bed-filter reactors fed with a synthetic sugar waste were operated at a specific loading rate of 0.6 to 1.8 g of chemical oxygen loading rate of 0.6 to 1.8 g of chemical oxygen demand per g of volatile suspended solid per day. One of these reactors was stepwise supplemented with a spent liquor rich in sulfonated lignin from a neutral sulfite semi-chemical (NSSC) pulping plant to reach an addition rate of 0.17 g sulfonated lignin/g volatile suspended solids per day; 50% of the sulfonated lignin was adsorbed onto the biomass. This resulted in pre-granulation of the anaer-obic sludge: 50-60% of the biomass was in particles > 0.3 mm versus 70-80% with a sizes < 75 micrometers in the control reactor. In addition, the sulfonated lignin supplementation slightly enhanced the specific metabolic activities of the biomass. Calcium ion addition following the sulfonat-ed lignin treatment enhanced the stability and the density of the aggregates. (See also W91-11467) (Author's abstract) W91-11482

THERMOPHILIC ANAEROBIC TREATMENT OF SULFATE-RICH PULP AND PAPER INTE-GRATE PROCESS WATER,

GRAIL FRUCESS WATER.
Tampere Univ. of Technology (Finland). Inst. of Water and Environmental Engineering.
J. Rintala, J. L. Sanz Martin, and G. Lettinga.
Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 149-160, 1991. 6 fig, 4 tab, 31 ref.

Descriptors: \*Anaerobic treatment, \*Pulp and paper industry, \*Pulp wastes, \*Sulfite liquors, \*Wastewater treatment, Chemical oxygen demand, Patty acids, Industrial wastes, Sludge digestion,

Anaerobic treatment of sulfate-rich (chemical oxygen demand/SO4 ratio 1.4-2.1) clarified whitewater from a thermomechanical pulping

process was studied in three laboratory-scale upflow anaerobic sludge blanket reactors at 55 C and in batch digesters at 55 and 65 C. Different and in batch digesters at 55 and 65 C. Different seed materials were used in the upflow anaerobic sludge blanket reactors. The highest chemical oxygen demand removal efficiency (effluent sulfide stripped) achieved was approximately 65% in the upflow anaerobic sludge blanket reactors. About 55% chemical oxygen demand removal efficiency was obtained at a loading rate of about 41 kg chemical oxygen demand/cubic m/day in the upflow anaerobic sludge blanket reactor seeded with themposhilic sludge cultivated with volatile with thermophilic sludge cultivated with volatile fatty acids. The total sulfide present in the liquid natty acids. The total sumoe present in the inquine phase after anaerobic treatment accounted for approximately 65-78% of the removed chemical oxygen demand in the batch digesters and 15-61% in the upflow anaerobic sludge blanket reactors. Sulfate reduction was almost complete in the batch digesters, whereas about 24-64% of sulfate was reduced in the upflow anaerobic sludge blanket resectors. Acetets willivation for culfate reductions are successived to the supplication for culfate reductions. reactors. Acetate utilization for sulfate reduction was apparent in the batch digesters, whereas that could not be demonstrated in the upflow anaerobic sludge blanket reactors. Sulfate reduction in the upflow anaerobic sludge blanket reactors was obviously substrate limited. Thermophilic anaerobic treatment is a viable alternative for the treatment of warm sulfate rich thermomechanical pulping process water. (See also W91-11467) (Author's abstract) W91-11483

BIODEGRADABILITY OF CHLORINATED ORGANIC COMPOUNDS IN PULP BLEACH-ING EFFLUENTS.

New York Univ. Medical Center, NY. Dept. of Microbiology.

Microbiology. M. Haggblom, and M. Salkinoja-Salonen. Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 161-170, 1991. 3 fig, 4 tab, 36 ref.

Descriptors: \*Biological treatment, \*Bleaching wastes, \*Chlorinated hydrocarbons, \*Industrial wastes, \*Pulp wastes, \*Wastewater treatment, Aerobic treatment, Anaerobic digestion, Biological oxygen demand, Chemical oxygen demand, Fluidized beds, Kraft mills, Pulp and paper industry.

The biodegradability of displacement bleaching effluents of kraft pulping was studied. A sequential treatment with an anaerobic fluidized bed and an aerobic trickling filter was effective in degrading the chlorinated high and low-molecular weight the chlorinated high and low-molecular weight material. The treatment significantly reduced the chemical oxygen demand, biological oxygen demand and the organic chlorine of the wastewater. Chemical oxygen demand and biological oxygen genand reduction was greatest in the aerobic process whereas dechlorination was significant in the anaerobic process. Less than 3% of the chemical oxygen demand removed was generated to sludge. With the combined aerobic and anaerobic treatment over 65% reduction of organic chloric treatment over 65% reduction of organic chloric bic treatment over 65% reduction of organic chlorine and over 75% reduction of chlorinated phenoinc and over 1996 reduction of chiornated pheno-lic compounds was observed. The chemical oxygen demand/organic chlorine ratio of the wastewater was similar before and after treatment, indicating that the chlorinated material was as biodegradable as the nonchlorinated. Microbes cabiodegradable as the nonchlorinated. Microbes capable of mineralizing pentachlorophenol constituted approximately 3% of the total heterotrophic microbial population in the aerobic trickling filter. Two aerobic polychlorophenol degrading Rhodococcus strains were able to degrade polychlorinated phenols, guaiacols and syringols in the bleaching effluent. (See also W91-11467) (Author's abstract) stract) W91-11484

OXIC FLUIDIZED-BED TREATMENT OF DICHLOROPHENOLS.

Tampere Univ. of Technology (Finland). Inst. of Water and Environmental Engineering. eering. vater and Environmental Engineering.
J. A. Puhakan, E. Melin, K. Jarvinen, T.
Tuhkanen, and W. K. Shieh.
Water Science and Technology WSTED4, Vol.
24, No. 3/4, p 171-177, 1991. 4 fig. 1 tab, 8 ref.

Descriptors: \*Aerobic digestion, \*Dichlorophenols, \*Fluidized bed process, \*Phenols, \*Pulp

wastes, \*Wastewater treatment, Biodegradation, Chemical properties, Chlorinated hydrocarbons, Pulp and paper industry.

Dichlorophenol degradation was studied under oxic conditions using celite carrier material for immobilization of microorganisms in fluidized-bed reactors. Stoichiometric release of chloride and total organic carbon removal from 2,4-dichlorophenol and 2,6-dichlorophenol indicated complete mineralization at hydraulic retention times of 1 hour for 2,4-dichlorophenol and 3 hours for 2,6-dichlorophenol. Gas chromatograph/mass spectro-photometer analyses showed no dichlorophenols or intermediary metabolites in the effluents. No 3,5-dichlorophenol degradation could be observed in the fluidized bed reactor. Microorganisms were in the fluidized bed reactor. Microorganisms were isolated from the reactor and their ability to degrade 2,4-dichlorophenol was evaluated in bioassays. 2,4-dichlorophenol degradation was slow by gram-variable rod and by gram-positive micrococcus, whereas the mixture of these isolates readily degraded 2,4-dichlorophenol. The results show that the amendability of dichlorophenol to aerobic biodegradation depends on the location of chlorine substituents in the ring structure. Dichlorophenol substituents in the ring structure. Dichlorophenol with both chlorine substituents in the meta position was recalcitrant towards aerobic degradation, whereas dichlorophenols with chlorine substituents whereas dictinophenois with chlorine substituents in ortho-para or ortho-ortho positions were readily degradable. It appears that oxic fluidized bed technology is a potential method for high-rate removal of chlorophenol contaminants from water. (See also W91-11467) (Mertz-PTT) W91-11485

TREATMENT OF BLEACHING EFFLUENTS IN AEROBIC/ANAEROBIC FLUIDIZED BIOFILM SYSTEMS.

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M. Fahmy, E. Heinzle, and O. M. Kut.

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 179-187, 1991. 10 fig, 2 tab, 9 ref.

Descriptors: \*Aerobic digestion, \*Anaerobic digestion, \*Biofilm reactors, \*Bleaching wastes, \*Fluidized beds, \*Pulp wastes, \*Wastewater treatment, Biodegradation, Chemical oxygen demand, Chlorinated hydrocarbons, Industrial wastes, Pulp and

Biodegradation of chloroorganic compounds in real industrial bleaching effluents (chlorination and extraction), with adapted biofilm in fluidized sand bed reactors, was studied under aerobic and anaer-obic conditions. The effluents were only diluted and supplied with mineral nutrients. Two reactor combinations were compared with a single stage aerobic digestor. In the anaerobic-aerobic reactors in series, the effluents were first treated anaerobically followed by an aerobic reactor in a single pass. In the anaerobic-aerobic recycle reactor, the reactor content was periodically moving back from aerobic to anaerobic fluidized beds. The reacfrom aerobic to anaerobic fluidized beds. The reac-tors were running continuously for one year. The most significant differences observed were be-tween aerobic and anaerobic single reactors. Gen-erally anaerobiosis reduced performance in terms of global parameters (chemical oxygen demand, nonpurgeable organic carbon, adsorbable organic halogen). With a residence time of 18 hours for each reactor, chemical oxygen demand and adsorb-able organic halogen typically decreased by 15-32% for each aerobic reactor system, where 32% for each aerobic reactor system, whereas a decrease of typically 4-15% was observed in the purely anaerobic system. From gas chromatograph and gas chromatograph/mass spectrometer analysis it was evident that in the anaerobic reactors, 2,4,6-trichlorophenol was first converted to 2,4-dichlorophenol. In all three systems 2,4,6-trichlorophenol. ophenol and dichlorophenols were almost com-pletely removed. (See also W91-11467) (Author's abstract) W91-11486

ONSET OF LIGNIN-MODIFYING ENZYMES, DECREASE OF AOX AND COLOR REMOVAL

### Waste Treatment Processes—Group 5D

BY WHITE-ROT FUNGI GROWN ON BLEACH PLANT EFFLUENTS, Helsinki Univ. (Finland). Dept. of General Micro-

biology. V. P. Lankinen, M. M. Inkeroinen, J. Pellinen, and

A. I. Hatakka. Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 189-198, 1991. 5 fig, 39 ref.

Descriptors: \*Biological treatment, \*Bleaching wastes, \*Fungi, \*Pulp wastes, \*Wastewater treatment, Biodegradation, Chlorinated hydrocarbons, Color, Enzymes, Pulp and paper industry.

Decrease of adsorbable organic chlorine is becoming the most important criterion for the efficiency of pulp mill effluent treatment in the 1990s. Two methods, designated MYCOR and MYCOPOR, that utilize the white-rot fungus Phanerochaete chrysosporium have been developed for the color removal of pulp mill effluents, but the processes also have a capacity to decrease the amount of chlorinated organic compounds. Lignin peroxi-dases (ligninases) produced by P. chrysosporium may dechlorinate chlorinated phenols. The use of selected white-rot fungi in the treatment of El-stage bleach plant effluent was studied. Phlebia radiata, Phanerochaete chrysosporium and Merulius (Phlebia) tremellosus were compared in shake flasks for their ability to produce laccase, lignin peroxidases and manganese-dependent peroxidases and to remove color from a medium containing effluent. Softwood bleaching effluents were treated by carrier-immobilized P. radiata in 2-liter bioreacby carrier-immobilized P. radiata in 2-liter bioreac-tors and a IO-liter Biostat-fermentor. Dechlorina-tion was followed using Cl(-) ion and organic chlorine determinations. All fungi removed the color of the effluent. In P. radiata cultivations organic chlorine decrease was about 4 mg/L in organic chlorine decrease was about 4 mg/L in one day. Apparent lignin peroxidase activities as determined by veratryl alcohol oxidation method were negligible or zero in a medium with organic chlorine content of about 60 mg/L, prepared using about 20% of softwood effluent. However, the purification of extracellular enzymes implied that large amounts of lignin peroxidases were present in the medium and, after the purification, in active form. Enzyme proteins were separated using anion exchange chromatography, and they were further characterized by electrophoresis to reveal the kind of enzymes that were present during organic chlo-rine decrease and color removal. The most charac-teristic lignin peroxidase isoenzymes in effluent media were ligninases. (See also W91-11467) (Au-

DECREASE OF POLLUTANT LEVEL OF BLEACHING EFFLUENTS AND WINNING VALUABLE PRODUCTS BY SUCCESSIVE FLOCCULATION AND MICROBIAL FLOCCULATION GROWTH.

Goettingen Univ. (Germany, F.R.). Forstbotan-

O. Milstein, A. Haars, F. Krause, and A. Huttermann.

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 199-206, 1991. 2 fig, 5 tab, 31 ref. Bundesministerium für Forschung und Technologies Wilder auch 1992 auch 1 gie grant 02-WA 382/03 18938-A.

Descriptors: \*Biological treatment, \*Bleaching wastes, \*Flocculation, \*Fungi, \*Pulp wastes, \*Waste recovery, \*Wastewater treatment, \*Water pollution control, Biodegradation, Chlorinated hydrocarbons, Glucose, Microorganisms, Pulp and paper industry, Sulfates.

The bulk of organic matter from spent bleaching effluent, either from chlorination and extraction stages or a mixture of both, can be precipitated with polycationic polymers. The mixtures of po-lyethylenimine and modified (containing cationic side groups) starches, can precipitate from bleach-ing effluent about 75% of adsorbable organic chloing effluent about 75% of adsorbable organic Chlorine, 59% of chemical oxygen demand and 80% of color. These mixtures contained less polyimine in comparison to when polyimine was used alone, thus saving material costs. After removal of chloroorganics of high molecular mass by precipitation growth of microorganisms in spent bleaching effluent was facilitated. The supernatant of the treated

spent bleaching effluent supplemented with glucose and ammonium sulfate supported active growth of fungi from different genera, particularly from Aspergillus spp., Pennicillium spp., Basidiomycetes, and Aureobasidiu. The fungi tested showed appreciable degradation activity regarding monochlorophenols, as well as additional reduction of adsorbable organic chlorine. During the growth in the treated spend bleaching effluent, Aurebasidium pullulans decreased the content of adsorbable organic chlorine remaining after precipitation, and at the same time synthesized and excreted in a surrounding media exopolysaccharides. Pollulan, synthesized in appreciable level by Aureobasidium sp., could easily be isolated from the media. Isolated exopolysaccharides synthesized in spent bleaching effluent might be considered as an additional benefit that eventually will be able to reduce further the running costs of the spent bleaching effluent treatment. (See also W91\_114671 (Author's abstract) will be able to reduce the training costs of the spent bleaching effluent treatment. (See also W91-11467) (Author's abstract) W91-11488

TREATMENT OF BLEACH-PLANT EF-FLUENTS WITH MEMBRANE FILTRATION AND SORPTION TECHNIQUES.

O. Ekengren, J. E. Burhem, and S. Filipsson. Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 207-218, 1991. 6 fig, 7 tab, 19 ref, 3

Descriptors: \*Bleaching wastes, \*Filtration, \*Membrane filters, \*Pulp wastes, \*Sorption, \*Wastewater treatment, Chemical oxygen demand, Chlorinated hydrocarbons, Pulp and paper industry, Reverse osmosis, Toxicity, Ultrafiltration, Waste disposal.

Laboratory experiments have been run with the combination of ultrafiltration and sorption techniques/reverse osmosis. The use of negatively charged membranes improved both the filtration capacity (flux) and the rejection of organochlorine compounds. The combination of ultrafiltration and reverse osmosis used to treat retention in the causcompounds. In e combination of ultrafilitation and reverse osmosis used to treat retention in the caustic extraction stage showed high removal of chemical oxygen demand, adsorbable organic chlorine and chloride ions (98.8-99.9%). The content of adsorbable organic chlorine in the reverse osmosis permeate was 0.08 g per ton pulp. The ultrafilitation of three different total bleachery effluents showed a chemical oxygen demand removal of 55-60% and an adsorbable organic chlorine removal of 65-75%. The decrease in toxicity was about 50% and the removal of substances with a bioaccumulation potential was around 90%. The treatment of this ultrafilitation-permeate with a weak-base anion exchanger gave even higher removal efficiencies, especially for the chlorophenolic compounds (93%), and the toxicity decreases five times. The sorbent did not show any remarkable loss in removal efficiency during the 48 loading and reactivation cycles. When treating the total bleachery effluents the combination of ultrafiltration and reverse osmosis also showed high removal efficiencies. It is not meaningful to make a cost tion and reverse osmosis also showed high removal uon and reverse osmosis also showed high removal efficiencies. It is not meaningful to make a cost estimation before these combinations have been studied for longer periods, on larger scales and with wide range of effluents. The problem of the final destruction of the pollutants that have been removed remains to be solved. (See also W91-11467) (Author's abstract)

MEMBRANE FILTRATION COMBINED WITH BIOLOGICAL TREATMENT FOR PURIFICA-TION OF BLEACH PLANT EFFLUENTS. Swedish Environmental Research Inst., Stock

B. Boman, M. Ek, W. Heyman, and B. Frostell. Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 219-228, 1991. 3 fig, 6 tab, 14 ref.

Descriptors: \*Aerobic treatment, \*Biological treatment, \*Bleaching wastes, \*Filtration, \*Kraft mills, \*Membrane filters, \*Pulp wastes, \*Wastewater treatment, Aerated lagoons, Biological oxygen demand, Chemical oxygen demand, Industrial wastes, Pulp and paper industry.

A bleach plant effluent from softwood kraft pulping was treated in the laboratory with a combination of ultrafiltration and different biological methods. The E-stage effluent was first membrane filtered using membranes with a nominal cut-off of 8000 Dalton. In the filtration, a concentration factor of 15 was used at 55 C. The treatment resulted in 89% adsorbable organic chlorine removal and 87% chemical oxygen demand removal. Calculated in relation to the actual flows of E-stage and (C+D)-stage effluent at the mill, this corresponded to adsorbable organic chlorine removal of 20% and chemical oxygen demand of 41%. Before the biological treatment, the permeate 41%. Before the biological treatment, the permeate was mixed with (C+D)-stage effluent and treated in three parallel biological systems, an aerated lagoon with and without solids recycle, an airlift system with a mixed fungal Hora and an anaeroom filter. For the lagoon treatment, a hydraulic retenstem with a mixed fungal flora and an anaerobic tion time of 7 days was used at biomass concentra-tions of 70, 350 and 480 mg total suspended solids/ tions of 70, 350 and 480 mg total suspended solids/ L and 20-22 C. The fungal system was evaluated at retention times of 5.5, 11 and 22 hours, 770 mg total suspended solids/L and 37 C. For the anaero-bic filter, retention times of 1, 5, and 25 hours at a temperature of 35 C were used. Very promising results were obtained with the combination of physical and biological treatment. The aerated lagoon with solids recycle gave the best results with 66% of adsorbable organic childring 73% of with 66% of adsorbable organic chlorine, 72% of chemical oxygen demand and 95% of the biologi-cal oxygen demand being removed in the com-bined process. The anaerobic filter also gave good results, but in practice a small aerobic post-treat-ment would probably be necessary. The three sys-tems were also evaluated for the removal of chlortems were also evaluated for the removal of the inated phenolic compounds and acute toxicity according to the Microtox test. The results suggest combination of membrane filtration a aerobic/aerobic or just aerobic treatment would be an attractive way to handle kraft mill bleach plant effluents. (See also W91-11467) (Author's abstract) W91-11490

TREATMENT OF PULP-BLEACHING EF-FLUENTS BY ACTIVATED SLUDGE, PRECIPI-TATION, OZONATION AND IRRADIATION. Universitaet fuer Bodenkultur, Vienna (Austria).

Inst. fuer Wasservorsorge.
R. Haberl, W. Urban, P. Gehringer, and W. Szinovatz.

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 229-239, 1991. 3 fig, 5 tab, 18 ref.

Descriptors: \*Activated sludge process, \*Bleaching wastes, \*Chemical precipitation, \*Irradiation, \*Ozonation, \*Pulp wastes, \*Wastewater treatment, Biodegradation, Biological oxygen demand, Chemical oxygen demand, Color, Flocculation, Kraft mills, Sulfite liquors.

The non-biodegradability of conventional pulp bleaching effluents represent a major wastewater disposal problem. Experience has shown that an extra stage treatment process is necessary to purify pulp bleaching sewages. The first stage (precipita-tion/flocculation oxidation with ozone, or highenergy radiation) allows resistant organic substances to be changed to biodegradable substances. The main elimination should be done in a biological stage, and remaining concentrations can be eliminated by a final treatment. Effluents of sulfite and kraft processes were treated to achieve the following elimination rates: about 90% five-day biological oxygen demand, 30-40% chemical oxygen demand, and 20-30% adsorbable organic chlorine. Precipitation with lime in addition to flocculation resulted in reduction rates of 40% chemical oxygen demand, 50% adsorbable organic chlorine, and 70% of the color. Such a pretreatment and a subsequent biological treatment in-creased the reduction rates to >95% five-day bio-logical oxygen demand, 70-80% chemical oxygen demand and 70-85% color. Treatment with ozone, demand and 70-57% COIOT. I reatment with a Coine, with and without simultaneous gamma-irradiation was carried out with native bleaching effluents at different temperatures and at different pH. These preliminary tests turned out to be unsatisfactory, probably because of the high amount of easily biodegradable substances in this sewage, which

### **Group 5D—Waste Treatment Processes**

reduced the effectivity of ozone/radiation. (See also W91-11467) (Mertz-PTT)

INVESTIGATION OF ANAEROBIC REMOVAL AND DEGRADATION OF ORGANIC CHLO-RINE FROM KRAFT BLEACHING WASTEWATERS.

Washington Univ., Seattle. Dept. of Civil Engi-

J. F. Ferguson, and E. Dalentoft. Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 241-250, 1991. 5 fig, 9 ref.

Descriptors: \*Anaerobic digestion, \*Bleaching wastes, \*Chlorinated hydrocarbons, \*Dechlorination, \*Kraft mills, \*Wastewater treatment, Acetates, Biological treatment, Hydrogen, Methane, Pulp and paper industry, Pulp wastes.

A study of anaerobic removal of adsorbable organ-A study of anaerooic removal of ausoroanic organ-ic halide from kraft bleaching wastes has been conducted, using bottle bioassay techniques. The anaerobic cultures were fed either acetate or hy-drogen and were able to remove from 40-65% of drogen and were able to remove from 40-65% of the adsorbable organic halide. The removal mecha-nism and the role of an adapted anaerobic consorti-um was investigated. Results indicated some bio-logical removal, but significant amounts of sorp-tion or degradation did not seem to require microbial activity. Significant inhibition of methanogenic activity was found in some tests. The evidence suggests that abiotic processes may be responsible for a major fraction of the removal observed. Wastewater presence is quite inhibitory to methan-ogenesis, more to acetoclasts than to hydrogen utilizers. When wastewater is present, substantial diversion of the electron donor, either acetate or hydrogen, from methane production has been seen.
Although the electron donor diversion far exceeds that necessary to reduce the organic chlorine, it is certainly possible that microbes carrying out re-ductive dehalogenation are involved in the use of ductive dehalogenation are involved in the use of hydrogen or acetate. In some tests the adsorbable organic halide removal clearly was not synchronous with methane production, indicating possible involvement of a microbial population other than methanogenous. Both these findings suggest that a growth supporting, oxidation/reduction reaction may be occurring in the presence of wastewater. (See also W91-11467) (Mertz-PTT)

### CRITERIA FOR NUTRIENT-BALANCED OP-ERATION OF ACTIVATED SLUDGE PROC-ESS.

Vysoka Skola Chemicko-Technologicka, Prague (Czechoslovakia). P. Grau.

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 251-258, 1991. 2 tab, 14 ref.

Descriptors: \*Activated sludge process, \*Limiting nutrients, \*Nitrogen, \*Phosphorus, \*Pulp wastes, \*Wastewater treatment, Ammonia, Iron, Magnesium, Molybdenum, Nitrates, Nutrient requirements

Though N and/or P are most frequently the limiting nutrients in industrial applications of the activated sludge process, there are other potentially limiting nutrients, especially Fe, Mg and Mo. Two different mechanisms exist in nutrient-limited biomass: multiple limitation of the growth rate and single nutrient limitation of the biomass crop. It is suggested that effluent concentrations of both NH3-N and NO3(-)-N be used as control parameters for nitrogen dosing adjustment. Dosing of both ammonia and nitrate to supplement nitrogen is considered for situations sensitive to total nitrogen discharge. Excess of nutrients in the effluent contributes to eutrophication and has to be minicontributes to eutrophication and has to be mini-mized. Lack or deficiency of nutrients results in lowered treatment efficiency and in sludge bulking. Addition of nutrients must therefore controlled in such a way that none of the extremes takes place. The rational for this is that excessive concentration of nitrate can be easily denitrified while excessive concentration of ammonia is not easy to remove in pulp and paper wastewater treatment plant conditions. Minimum soluble phosphorus concentrations of about 0.5 mg/L have been reported as required

for reliable operation. In many cases, however, lower concentrations are maintained without any adverse effects to the process. Soluble orthophosphate is not an adequate control parameter for phosphate dosing since some of the phosphate precipitates can be utilized by microorganisms. Ap-propriate methods for assessing their availability to microorganisms in real situations are still missing. (See also W91-11467) (Mertz-PTT)

### NITROGEN AND PHOSPHORUS LIMITS FOR NUTRIENT DEFICIENT WASTEWATERS.

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C. H. Mobius.
Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 259-267, 1991. 5 fig, 2 tab, 7 ref.

Descriptors: \*Activated sludge process, \*Biological treatment, \*Nitrogen, \*Phosphorus, \*Pulp wastes, \*Wastewater treatment, \*Water pollution control, Biological oxygen demand, Denitrifica-tion, Industrial wastes, Nitrification, Nutrient requirements, Pulp and paper industry

Biological treatment of nutrient deficient industrial Biological treatment of nutrient deficient industrial wastewaters, such as those of the pulp and paper industry, require the addition of nitrogen and phosphorus. As a certain surplus is necessary, both elements will be found in the effluent in varying the control of the contr concentrations. Activated sludge treatment uses 5 parts of N and one part of P for elimination of 100 parts biological oxygen demand. In-plant optimiza-tion generally leads to about 3.5 parts of N and 0.6 parts of P for 100 parts of biological oxygen demand. N is normally added as urea and P as phosphoric acid. Optimized nutrient dosages usually results in concentrations of 1 mg/L of both ammonia N and phosphate P in the treated effluent, with maximum concentration in 24-hour mixed samples of more than 10 mg/L for both N and P Water quality requirements will impose general limitations on N and P concentrations in treated effluents. Nutrient dosage should become state of the art in the near future. The next step will be a loading dependent dosage. No results of technical operation are known which show the effluent concentrations obtainable with this techniques. For centrations obtainable with this techniques. For cases in which limits cannot be met with this strategy the possibilities of nitrification, denitrification and biological P removal were examined for nutrient deficient wastewaters. Results showed that nitrification will work at low ammonia concentrations, however, no steady nitrification would be obtained. Denitrification, on the other hand, seems to be difficult with low nitrate concentrations. At present, no technical process meeting stringent total N or total inorganic N limits is known to exist for nutrient deficient wastewaters. Low P concentrations in the effluent can only be achieved by tertiary treatment, preferably final flocculation filtration processes. (See also W91-11467) (Mertz-PTT) W91-11494

## CONDUCTIVITY FOR NUTRIENT CONTROL IN CTMP WASTEWATER TREATMENT. Scanyironment, St Ror, S-386 00 Farjestaden,

B. Rosen, R. Modell, L. Bruneau, and L

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 269-275, 1991. 3 fig, 3 tab, 5 ref.

Descriptors: \*Activated sludge process, \*Chemical treatment, \*Conductivity, \*Process control, \*Pulp wastes, \*Wastewater treatment, Analytical methods, Biological oxygen demand, Chemical oxygen demand, Organic matter, Pulp and paper industry.

At the 60,000 ton/year CTMP (chemo-thermo-mechanical pulping) mill at Vaggerty in southern Sweden, which began operations in May 1989, a two-stage activated sludge plant with pre-precipi-tation and post-precipitation, has been installed for reducing the incoming biological oxygen demand from 12 tons per day to less than 500 kilo per day. The results normally show a biological oxygen demand reduction of 96-98% and a chemical

oxygen demand reduction of 75-85%, or less than 250 and 1800 kg/day in the effluent. The possible use of conductivity as the measurement of the incoming organic content was studied. Observations indicated a correlation between chemical oxygen demand in the influent and conductivity. The amount of chemicals being used in the CTMP process influence the dissolving of organic matter into the wastewater. Conductivity meters are very robust and reliable, and the possibility of using such a simple method for measurement of the such a simple method for measurement of the organic content in the wastewater lead to installaorganic content in the wastewater lead to installa-tion of instruments. For actual wastewater, the correlation between conductivity and the chemical oxygen demand-content in the influent was good. As the chemical oxygen demand in the influent can be predicted with less than 20% deviation by the use of conductivity measurement, the dosage of nutrient can be easily and reliably controlled. (See also W91-11467) (Mertz-PTT) W91-11495

## PRACTICAL EXPERIENCE WITH BIOLOGICAL REMOVAL OF PHOSPHORUS FROM PULP AND PAPER MILL EFFLUENTS,

Metsa-Seria Oy, 08800 Kirkniemi, Finland.

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 277-286, 1991. 2 fig, 1 tab, 23 ref.

Descriptors: \*Biological treatment, \*Phosphorus, \*Phosphorus removal, \*Pulp and paper industry, \*Pulp wastes, \*Wastewater treatment, Aerobic treatment, Anaerobic digestion, Bacteria, Finland, Water pollution control, White water.

Effluent discharges in Finland have decreased steadily during the past two decades. The two traditionally largest polluters, the pulp and paper industry and the municipalities, have been able to reduce their discharges by 70-90% since 1970. Presently, Finland's total phosphorus discharge is estimated at 3000-6000 ton/year. The forest industry discharges about 800 tons/year. Removal of participals from wastewaters by hiological means. try discharges about 800 tons/year. Removal of nutrients from wastewaters by biological means, without the utilization of chemicals, has been among the principal goals of wastewater research for many years. Worldwide, a few hundred treatment plants utilize biological P removal. Nearly all the plants constructed so far are treating municipal sewage. There are numerous processes and process modifications able to remove more than 90% of the phosphorus from the effluents. All the processes are modifications of the conventional activated es are modifications of the conventional activated sludge method. A common feature is that the wastewater and/or biological sludge is subjected to anaerobic conditions at some stage of treatment, preferably before being led off for aeration. This creates favorable conditions for the growth of bacteria able to absorb excessive amounts of P. Of the several different bacteria able to bind P, the so-called polyP bacteria, the best known is Acinetobacter spp. At plants where biological P removal is practiced, Acinetobacter can represent up to 2/3 of the bacterial population. Pulp and paper effluents are ideally suited for biological P removal; waters are warm, suitable food is available in quantity and the concentration of P is low. Metsa-Serla Oy and the concentration of P is low. Metsa-Serla Oy and tis subsidiary have pulp and paper production at eight locations in Finland. Total P discharge is about 300 kg/day. At the beginning of 1989, plant-scale experiments were started at the Kirkniemi paper mill. The results have been promising, with the highest removal rates obtained at over 90%. The good P removal at the plant is biological in nature and a polyP mechanism is probably involved. The occurrence of Acinetobacter in large quantities in the white water system of the Kirkniemi plant could explain the rapid start-up of the P removal process. (See also W91-11467) (Mertz-PTT) PTT) W91-11496

## BIOLOGICAL DEHALOGENATION KRAFT MILL WASTEWATERS.

Arizona Univ., Tucson. Dept. of Civil Engineer-

Ing. C. W. Bryant, and W. A. Barkley. Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 287-293, 1991. 3 tab, 13 ref.

### Waste Treatment Processes—Group 5D

Descriptors: \*Biological treatment, \*Chlorinated hydrocarbons, \*Dehalogenation, \*Pulp wastes, \*Wastewater treatment, Aerated lagoons, Aerobic treatment, Chlorine, Industrial wastes, Kraft mills, Pulp and paper industry, Wastewater re

A single-stage aerobic biological treatment system was developed specifically to convert organically bound chlorine to inorganic chloride. The pilot reactor for wood preservative wastewater was an aerobic, packed-bed, upflow reactor. The pilot reactor for kraft wastewater was of a considerably different configuration. Within an operating kraft aerated lagoon, five reaction zones were created in series. Each zone consisted of an open aeration area followed by a packed media area. In initial series. Each zone consisted of an open aeration area followed by a packed media area. In initial laboratory tests, greater than 90% reduction of adsorbable organic halide was achieved in synthetic dichlorophenol, commercial pentachlorophenol, and combined kraft wastewaters, and less than a week was required for startup/acclimation. A sixmonth field test of the process on a pentachlorophenol, wastewater, was very successful under the process of the proc phenol wastewater was very successful under highly variable influent conditions. No chlorinated byproducts were detected, and measurements strongly indicated that dehalogenation had occurred. Recent experiments found C1/E1 wastewater to be most easily treatable by the aerowastewater to be most easily treatable by the aero-bic process, followed by combined lagoon influent, E1 wastewater, and finally lagoon effluent. How-ever, results have indicated that application of the treatment process to kraft adsorbable organic halide reduction can become feasible only if fur-ther process improvements can be made. (See also W91-11467) (Mertz-PTT) W91-11497

FACTORS AFFECTING THE REMOVAL AND DISCHARGE OF ORGANIC CHLORINE COM-POUNDS AT ACTIVATED SLUGGE TREAT-MENT PLANTS. Finnish Pulp and Paper Research Inst., Helsinki. R. Saunamaki, K. Jokinen, R. Jarvinen, and M.

Savolainen.
Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 295-307, 1991. 11 fig, 4 tab, 30 ref.

Descriptors: \*Activated sludge process, \*Chlorinated hydrocarbons, \*Halides, \*Phenols, \*Pulp wastes, \*Wastewater treatment, Aerobic treatment, Anaerobic lagoons, Biological wastewater treat-ment, Industrial wastes, Pulp and paper industry, Wastewater disposal.

Tests were performed to find out to what extent Tests were performed to find out to what extent and in what way organic chlorine compounds (adsorbable organic halides, chlorinated phenols) are reduced in an activated sludge process. In an extended aeration activated sludge plant the reduction of adsorbable organic halide was 40-50% and that of chlorinated phenols 70-80%. In a high-load activated what salar the accuracy files removable activated which a lant the accuracy files removable. activated sludge plant the corresponding removals were only 20-30% and 35-55%. The removal oxygen-consuming substances was also lower in the high-load plant. It is evident that most of the chlorinated organics, especially low molar mass compounds, are removed by microbiological action. About 0.05-0.2 kg adsorbable organic halogen/ton of pulp was removed from the system with the excess biosludge, to be mixed with primary sludge and finally either burned or used as landfill. At the extended aeration activated sludge landfill. At the extended aeration activated sludge plant the adsorbable organic halide discharge to the recipient was only 1.3 kg/ton when birch was the chief raw material. The corresponding figure at the high-load plant was 65% if the fiber raw material was softwood. A detailed study revealed differences in the microorganisms present in the aeration sections of the plants. For example, there were practically no protozoa present in the high-load plant, and the number of species of bacteria was also smaller than in the low-load plant, where thermophilic bacteria and fungi were typically present. Tests carried out under controlled laboratory conditions showed that changes in conditions in the aeration section had little effect on the in the aeration section had little effect on the removal of adsorbable organic halide, but a considerable effect on the removal of low molar mass compounds such as chlorinated phenols. An anaerobic/facultative lagoon before or after the activated sludge process did not improve the removals. Removing colloidal material from biologically

treated effluents had a great influence on adsorbable organic halogens. (See also W91-11467) (Author's abstract)

TREATABILITY OF BLEACHED KRAFT PULP AND PAPER MILL WASTEWATERS IN A NEW ZEALAND AERATED LAGOON TREAT-Waikato Univ., Hamilton (New Zealand). Dept. of

Chemistry.

T. R. Stuthridge, D. N. Campin, A. G. Langdon,
K. L. Mackie, and P. N. McFarlane.

Water Science and Technology WSTED4, Vol.
24, No. 3/4, p 309-317, 1991. 5 fig, 3 tab, 30 ref.

Descriptors: \*Aerated lagoons, \*Biological treatment, \*Bleaching wastes, \*New Zealand, \*Pulp wastes, \*Wastewater treatment, Chlorinated aromatic compounds, Chlorinated hydrocarbons, Kraft mills, Organic matter, Pulp and paper indus-

The effectiveness of the two biological treatment systems operating at a New Zealand bleached kraft softwood integrated pulp and paper mill was assessed. The two systems operated in different configurations. Treatment system A, which received general mill wastewaters and chlorination stage bleaching discharges utilized deep, aerated lagoons and had a 4.5 day retention time. Treatment system B, which received alkali extraction bleaching and nao a 4.5 day retention time. I reatment system B, which received alkali extraction bleaching wastewaters and foul condensates, used a lagoon system with a retention time of 45 days. Detailed chemical analyses of the untreated and treated chemical analyses of the intreated and treated wastewaters were made. Mass balances were calculated for a range of physical parameters and for specific chlorinated and non-chlorinated organic constituents. Significant differences in the treatability of various constituents were found. In particu-lar, while system A was able to reduce levels of lar, white system A was able to reduce levels of adsorbable organic halide by 65%, no significant reduction in adsorbable organic halide occurred in system B. In contrast, system B reduced levels of chloracetic acids by 34%, whereas system A did not achieve any statistically significant removal of these compounds. The treatability of chlorophenolic compounds also differed. System A was unable remove chlorophenols and chloroguaiacols, ile system B did not reduce levels of chlorocatewhile system but not reduce levers of conforcate-cols. These results confirm that the treatability of bleached kraft pulp and paper mill wastewater constituents is dependent upon the characteristics of the treatment systems and the compositions of the wastewaters. (See also W91-11467) (Author's abstract) W91-11499

TREATMENT TECHNOLOGIES FOR ORGAN-OCHLORINE-CONTAINING SLUDGES AND CONCENTRATES FROM EXTERNAL TREAT-MENT OF WASTEWATERS. PULP AND

Swedish Environmental Research Inst., Stock-

M. Almemark, G. Finnveden, and B. Frostell. Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 319-329, 1991. 7 tab, 36 ref.

Descriptors: \*Chlorinated hydrocarbons, \*Pulp wastes, \*Sludge disposal, \*Sludge treatment, \*Wastewater disposal, \*Wastewater treatment, Activated sludge process, Chemical coagulation, Chlorinated aromatic compounds, Filtration, Pulp and paper industry, Sweden.

Literature data and results from current Swedish research have been used to compile characteristics research have been used to compile characteristics of and disposal method for sludges and concentrates from external treatment of wastewaters from the pulp and paper industry. Very little sludge from aerobic lagoon treatment in Sweden is handled, and most of the solids are deposited in the receiving waters. In North America, Finland and Japan, where activated sludge treatment is used to a great extent, sludge handling is an important part of the kraft mill effluent treatment. Typically, 5-15 kg of dry solids has to be handled per ton of pulp with a process discharge of 15-20 kg of five-day biological oxygen demand. For chemical coagula-tion, the amounts of sludges produced are higher,

typically 40-80 kg dry solids. Especially in Japan, chemical coagulation is used to a great extent. Laboratory and pilot-plant experiments with ultrafiltration of alkaline stage and total bleach plant effluents suggest that concentrates with a total solids content of approximately 20 and 50 kg dry solids are produced. The concentrations of organochlorine compounds in sludges and concentrates have not hitherto been well documented, and nor have not hitherto been well documented, and nor have environmental effects of different disposal methods. Chlorinated phenols, catechols and guaiacols have been found in variable concentrations; chlorinated dibenzodioxins and furans have also been detected. Vacuum filters and especially belt filter presses have been used to dewater sludges. Typical dry solids concentrations achieved vary from 20-35% for primary sludges to 15-20% for secondary sludges, Anaerobic digestion may be applied before dewatering of sludges, and methane yields of 200-400 L CH4/kg volatile solids removed have been reported. Sludge has solids removed have been reported. Sludge has been disposed of in landfills or incinerated. Leachates from landfilliling of pulp and paper industry sludges may contain high levels of soluble organic material, but available information suggests that organochlorine compounds do not leach to a substantial extent. Incineration of pulp mill sludges and concentrates seems to be an increasingly at-tractive method. (See also W91-11467) (Author's abstract) W91-11500

ANAEROBIC TREATMENT OF BLEACHED TMP AND CTMP EFFLUENT IN THE BIOPAQ UASB SYSTEM.

Paques B.V., Balk (Netherlands).

L. H. A. Habets, and A. L. de Vegt. Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 331-345, 1991. 9 fig, 7 tab, 20 ref.

Descriptors: \*Anaerobic digestion, \*Bleaching wastes, \*Chemical treatment, \*Pulp wastes, \*Wastewater reactors, \*Wastewater treatment, Canada, Finland, Hydrogen peroxide, Industrial wastes, Methanogenesis, Pulp and paper industry, Studen.

The effluents from CTMP chemo/thermo/me-chanical pulping) mills are on the one hand too dilute for evaporation and recovery, and on the other hand too highly polluted for conventional aerobic secondary treatment. In the summer of 1986, an extensive research program was started in cooperation with Finnish and Canadian engineercooperation with Finnish and Canadian engineer-ing firms in order to investigate the anaerobic treatability of CTMP effluent, using upflow anaer-obic sludge bed technology. Laboratory studies, as well as on-site pilot work was conducted in Fin-land and Canada. As a results of this research, two land and Canada. As a results of this research, two full-scale plants are in operation. The first plant was started up in October 1988 at Quesnel River Pulp in B.C. Canada, and is treating up to 140 tons of chemical oxygen demand per day in two reac-tors of 3500 cubic m each. The second plant was ready for start-up in January 1990 at the Enso-Gutziet Kotka mill in Finland. The cautious approach for these types of effluents was necessary due to earlier reports on the toxicity of softwood extractives, bleaching agent hydrogen peroxide, complexing agent and high sulfur levels. Besides this, it was necessary to confirm that granular seed sludge would not deteriorate but would develop normally. The behavior of hydrogen peroxide was especially interesting and the high redox potential especially interesting and the high redox potential caused could be resolved in a very cost-efficient way without utilizing chemicals, enzymes or activated sludge. Resin acids were identified to be responsible for reducing methanogenic activity considerably. They were eliminated during aerobic post-treatment to very low levels. Lab studies clearly demonstrated how methanogenic activity could be increased by adding dilution water or aerobically treated effluent. The concentration of the resin acids appeared to be associated with raw aeronically treated efficient. The concentration of the resin acids appeared to be associated with raw material (spruce, fir or pine), the season (summer or winter) and with fine fibrous material in the effluent. Sulfur levels in the effluent were relatively high, but resulting sulfide levels were not toxic to methanogens and chemical oxygen demand/ sulfur ratios were high enough to achieve accepta-

### **Group 5D—Waste Treatment Processes**

ble removal efficiencies. (See also W91-11467) (Author's abstract) W91-11501

BIOTECHNOLOGICAL SULPHIDE REMOV-AL FROM EFFLUENTS.

AL FROM EFFLUENTS.
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Dept. of Water Pollution Control.
C. J. N. Buisman, G. Lettinga, C. W. M.
Paasschens, and L. H. A. Habets.
Water Science and Technology WSTED4, Vol.
24, No. 3/4, p 347-356, 1991. 4 fig, 6 tab, 14 ref.

Descriptors: \*Biological wastewater treatment, \*Pulp and paper industry, \*Sulfite liquors, \*Wastewater reactors, \*Wastewater treatment, Bacteria, Industrial wastes, Pulp wastes, Sulfur, Sulfur bacteria. Thiobacillus.

which sulfide was converted to elemental sulfur using colorless sulfur bacteria, Thiobacillus spp. A 4 cubic m biorotor reactor was tested using spp. A A new system for sulfide removal was examined in c m biorotor reactor was tested using sulfide-4 cubic in biorotor reactor was tested using suffice-containing anaerobically treated papermill wastewater. The removal plants were located at a wastewater treatment facility in the Netherlands. The plant treats the wastewater from three separate papermills with a total production approaching 300,000 tons/year. Experiments with lab-scale reactors were conducted in order to assess the feasibility of different kinds of carrier material. Experiments with the pilot-plant biorotor reactor were conducted in order to optimize the sulfide removal process. Important parameters of the process were the flow rate of the wastewater, the flow rate of the required air, the rotation speed of the cage, and kind of carrier material and the H2S concentration in the effluent air. Sulfide removal efficiencies well above 90% were achieved at a hydraulic retention time of 19 minutes, using Pall hydraulic retention time of 19 minutes, using Pall rings of 2.5 cm or Bio-Net 200 as carrier materials. Reticulated polyurethane was not suitable as carrier material for the sulfide removal process in the presence of fatty acids. The results showed that there is a real potential for sulfur recovery from anaerobically treated effluent. (See also W91-11467) (Mertz-PTT) W91-11502

THERMOCATALYTIC AND CHEMICAL TREATMENT OF LIGNIN-ALUMINIUM SLUDGE AND UTILIZATION OF THE RESULTING ADSORBENT-COAGULANT. Leningrad Technological Inst. for the Pulp and Paper Industry (USSR). I. V. Wolf, Y. M. Chernoberezhsky, E. I. Jepifantseva, and A. D. Simonov. Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 357-360, 1991. 2 fig, 1 tab, 2 ref.

Descriptors: \*Adsorbents, \*Chemical coagulation, \*Lignin, \*Pulp wastes, \*Sludge disposal, \*Sludge treatment, \*Wastewater treatment, Aluminum sulfate, Chemical oxygen demand, Color, Industrial wastes, Kraft mills, Pulp and paper industry.

Lignin compounds from kraft pulping are slowly biodegradable and usually not removed in the con-ventional biological treatment. Chemical coagulation can be used to improve lignin removal. The Baikal Pulp and Paper Mill in the USSR has a Balkal Pulp and Paper Mill in the OSS has a set tertiary wastewater treatment with aluminum sulfate. The produced lignin sludge contains 18-23% of mineral substances and 77-82% of organic matter. The use of chemicals adds sludge disposal problems and treatment costs. A new sludge disposal problems are treatment costs. A new sludge disposal problems are treatment to the cost of the ligning additional solutions and treatment costs. posal process was developed. The lignin-aluminum sludge from the settling basin was first converted into adsorbent by using a thermocatalytic reactor. The produced adsorbent was further refined to adsorbent-coagulant by chemical treatment such as aluminum sulfate. The generated aluminium sludge was converted into adsorbent-coagulant by thermocatalytic and sequential chemical disposal. A thermocatalytic reactor with the temperature range from 400-700 C and with copper-chromium catalyst was applied to treat the aluminum sludge. catalyst was applied to treat the aluminum studge.

The resulting adsorbent-coagulant removed color up to 95% and chemical oxygen demand up to 75% from diluted kraft liquor. This method simultaneously solves sludge disposal problems and makes it possible to regenerate coagulant. (See also W91-11467) (Mertz-PTT) W91-11503

ACTIVATED SLUDGE TREATMENT OF KRAFT MILL EFFLUENTS FROM CONVEN-TIONAL AND OXYGEN BLEACHING. Tampere Water and Environmental District (Fin-

land) J. Nevalainen, P. R. Rantala, J. Junna, and R

Lammi.

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 427-430, 1991. 2 fig, 3 tab, 2 ref.

Descriptors: \*Activated sludge process, \*Bleaching wastes, \*Chlorinated hydrocarbons, \*Kraft mills, \*Pulp wastes, \*Wastewater treatment, Chemical oxygen demand, Chlorinated aromatic compounds, Oxidation, Pulp and paper industry, Westewater enduring Wastewater analysis.

Conventional and oxygen bleaching effluents from hardwood kraft pulp mills were treated in labora-tory-scale activated sludge processes. The main interest was the fate of organochlorine compounds in the activated sludge process. In the treatment of conventional bleaching wastewaters the 7-day biological oxygen demand-reduction was 80-91% and in oxygen bleaching wastewaters 86-93%. The respective chemical oxygen demand removals were about 40% for conventional bleaching and 50% for about 40% to conventional teaching and 50% to oxygen bleaching. The adsorbable organic halogen reductions were on average 22% in the treatment of conventional and 40% in oxygen bleaching effluents. The reductions of chlorinated phenols, guaiacols, and catecols were usually more than 50% in both reactors. Very little accumulation of adsorbable organic halogens into the sludge was observed. The stripping of adsorbable organic halogens from aeration unit was insignificant. (See also W91-11467) (Author's abstract)

ANAEROBIC DEGRADATION OF PCP AND PHENOL IN FIXED-FILM REACTORS: THE INFLUENCE OF AN ADDITIONAL SUB-

Technical Univ. of Denmark, Lyngby. Inst. for

Bioteknologi.
H. V. Hendriksen, S. Larsen, and B. K. Ahring.
H. V. Hendriksen, S. Larsen, and B. K. Ahring. Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 431-436, 1991. 3 fig, 1 tab, 12 ref.

Descriptors: \*Anaerobic digestion, \*Biofilm reacors, \*Chlorinated aromatic compounds, \*Phenols, \*Wastewater reactors, \*Wastewater treatment, Biodegradation, Biomass, Glucose, Sludge.

anaerobic degradation of pentachlorophenol (PCP) and phenol was examined in two lab-scale fixed-film reactors. Anaerobic digested sewage inted-nim reactors. Anaeronic tigestees sewage sludge from a municipal treatment plant was used as inoculum. The reactors were fed a mineral medium containing PCP (1-2 mg/L) and phenol (4-6 mg/L). In addition one of the reactors received 1 g/L glucose as an easily degradable carbon source. After 6 months of continuous opercaroon source. After 6 monits of continuous operation, the removal of PCP in the reactor with no glucose added was approximately 60%, whereas the removal in the reactor with glucose reached 98%. Tetrachlorophenol and trichlorophenol were found as degradation products and the removal of these compounds was also significantly enhanced by the presence of glucose. Phenol degradation was approximately 70% with glucose added and 95% without glucose. Examination of the inert carrier in the two reactors showed that biofilm formation occurred primarily in the reactor receiving glucose as an addition carbon source. In this reactor the biomass was both an immobilized film and a sludge bed caught between the Raschig rings. In the reactor with no glucose, the biomass was concentrated in the sludge bed. (See also W91-11467) (Mertz-PTT) W91-11512

QUALITY OF SALMONID HATCHERY EF-FLUENTS DURING A SUMMER LOW-FLOW SEASON.

Vashington State Dept. of Ecology, Olympia.

W. Kendra.

Transactions of the American Fisheries Society TAFSAI, Vol. 120, No. 1, p 43-51, January 1991. 3 fig, 4 tab, 21 ref.

Descriptors: \*Effluents, \*Fish hatcheries, \*Wastewater pollution, \*Wastewater treatment, \*Water pollution effects, \*Water pollution sources, Ammonia, Benthic fauna, Chemical oxygen demand, Hydrogen ion concentration, Invertebrates, Nitrogen, Nutrients, Oligotrophy, Permits, Phosphorus, Salmon, Sedimentation, Stream biota, Suspended solids, Temperature, Trout, Water quality standards

The quality of salmonid hatchery effluents and receiving streams in Washington State was assessed during the 1988 summer low-flow period. Relative to hatchery influent waters, effluents showed significant increases in temperature, pH, suspended solids ammonia organic pitrogen to period. suspended solids, ammonia, organic nitrogen, total phosphorus, and chemical oxygen demand. Wastewater discharges sometimes violated state water quality standards; effects were exacerbated by low dilution. Hatchery nutrient loads equaled or exceeded receiving water loads; effects of en-richment were most evident in oligotrophic waters. Benthic invertebrates sensitive to organic waste were often replaced by pollution-tolerant forms in the vicinity of hatchery outfalls. Hatchery torns in the vicinity of haterery outlants. Fractiery discharges to Scatter Creek provided phosphorus loading equivalent to secondarily treated sewage discharge from a town of 2,300 people, while phosphorus loading to Cinebar, Canyonfalls, and Issaquah Creeks corresponded to sewage effluent loads from communities of 900, 1,300, and 300 people, respectively. Stream invertebrates experienced moderate change upon exposure to hatchery ef-fluents, although altered communities largely recovered within 0.5 km downstream of a dis Results necessitated revision of existing hatchery wastewater discharge permits in Washington. Sedimentation of waste solids was stipulated as a minimum requirement, and phosphorus loading con-trols may be applied in fresh waters deemed sensitive to nutrient enrichment. (Doria-PTT) W91-11532

PRE-HYDROLYZED ALUMINUM HYDROX-IDE AND IRON HYDROXIDE IN ACTIVATED SLUDGE TREATMENT.

Pennsylvania State Univ., University Park. Dept. of Civil Engineering.

R. B. Bowen.

Water Pollution Control Association of Pennsylva-nia Magazine, Vol. 24, No. 3, p 10-14, May/June 1991. 7 fig, 1 tab, 5 ref.

Descriptors: \*Activated sludge process, \*Aluminum, \*Chemical precipitation, \*Iron, \*Wastewater treatment, Biological oxygen demand, Biological wastewater treatment, Chlorides, Hydrogen ion concentration, Hydroxides, Sludge volume index, Sulfates, Suspended solids.

Iron and aluminum are used in physical-chemical precipitation treatment of wastewater to remove colloidal organic material and inorganic phosphate. The use of iron and aluminum salts in biological activated sludge treatment was examined. The best treatment was obtained for reactors that received additions of metal hydroxides. Addition of metal additions of metal hydroxides. Addition of metal salts without prehydrolysis generally led to pH perturbation and thus did not result in improved removals of biological oxygen demand (BOD) and suspended solids (SS). Exceptions were lower effluent SS with 18 mg/L and 28 mg/L FeCl3 additions than the average SS for control reactors and an overall lower sludge volume index (SVI) and lower effluent BOD with the 28 mg/L A12/SCV43 addition than the average SVI and Al2(SO4)3 addition than the average SVI and BOD for the control reactors. The success of the Al2(SO4)3 addition may be due to the higher pH level that was maintained in its reactor relative to the pH of the other Al2(SO4)3 and FeCl3 addition the ph of the other AL(SO4)3 and Fe(L)3 addition reactors. Al(OH3) addition produced the lowest effluent BOD followed by Fe(OH)3 addition. However, the iron hydroxide reactors had lower effluent SS and a lower SVI than did the reactors with aluminum hydroxide added. The reactors with iron hydroxide at 3.5% of the mixed liquor

### Ultimate Disposal Of Wastes—Group 5E

suspended solids (MLSS) had effluent BOD and suspended solids (MLSS) and effluent BOD and SS lower than that for the reactor with iron hy-droxide at 7% of the MLSS. The reactor with 7% iron hydroxide had a lower SVI than the reactor with 3.5% iron hydroxide. It is concluded that addition of prehydrolyzed metal salts results in improved biological treatment. (Doria-PTT) W91-11539

MANAGING TOXIC SUBSTANCES IN MUNIC-IFAL WASTEWATER TREATMENT PLANTS. Springettsbury Township Wastewater Treatment Facility, PA. M. A. Kyle.

Water Pollution Control Association of Pennsylva-nia Magazine, Vol. 24, No. 3, p 26-32, May/June 1991. 4 fig, 11 ref.

Descriptors: \*Municipal wastewater, \*Permits, \*Toxic wastes, \*Wastewater treatment, \*Water pollution control, \*Water quality standards, Administrative agencies, Legal aspects, Optimization, Pennsylvania, Technology, Wastewater facilities.

Faced with the requirement to meet stringent effluent limitations based on receiving stream quality for nonconventional pollutants (toxics), the municifor nonconventional pollutants (toxics), the municipal wastewater plant operator in Pennsylvania can attempt one or more of the following actions: (1) petition the state Department of Environmental Resources (DER) to relax the plant effluent limits; (2) remove the pollutants from the liquid stream after they enter the treatment plant; or (3) reduce the influence load of toxics entering the plant. the influence load of toxics entering the plant. Process control strategies to optimize toxics re-moval depends on the pollutant class. The first steps in developing a toxics control program are to determine if there is a 'toxicity' problem and to identify the specific compounds causing the prob-lem. In some cases, the DER may determine that the permittee does have a problem, and may re-quire a Toxics Reduction Evaluation (TRE) as part of the effluent discharge permit. The purpose part of the effluent discharge permit. The purpose of a TRE is to define the quantities of pollutants, identify their sources, determine their fates, and recommend control technologies that will control or eliminate them. By developing a toxics control program that includes the technical evaluation of proposed limits, the use of optimum treatment technology, and the control of industrial discontrology, and the control of industrial dis-charges, a publicly owned treatment works has a good chance of not experiencing passthrough of pollutants into receiving waters, or of having a permit violation. (Doria-PTT)

NEW STORM WATER REGULATIONS REQUIRE SIGNIFICANT COMPLIANCE ACTIONS BY BOTH INDUSTRIES AND MUNICI-

PALITIES.
BCM Engineers, Inc., Plymouth Meeting, PA.
K. Horstman, and J. Sartor.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 24, No. 3, p 35-37, May/June

Descriptors: \*Permits, \*Regulations, \*Storm runoff, \*Storm water management, \*Urban runoff, \*Wastewater facilities, \*Water pollution sources, Costs, Enforcement, Land disposal, Pennsylvania, Storm sewers. Storm wastewater.

New storm water discharge regulations just published by the U. S. Environmental Protection Agency (EPA) could have a major impact on wastewater treatment plants in Pennsylvania. The regulations require municipal and industrial wastewater treatment plants to obtain storm water discharge permits and to implement measures to control pollutants in storm water discharges. Permitting and enforcement will be the responsibility of the Pensylvania Department of Environmental mitting and enforcement will be the responsibility of the Pennsylvania Department of Environmental Resources (DER) under the National Pollutant Discharge Elimination System (NPDES). The following facilities must comply: (1) facilities with a design flow greater than or equal to 1.0 million gallons per day; (2) facilities required to have an approved pretreatment program under 40 CFR Part 403; and 3) land application sites outside the confines of a treatment plant where sludge is not directly used for farmlands, domestic gardens, or

some other beneficial purpose. Both area-wide and site-specific storm water drainage systems are covered, and municipalities must prohibit nonstorm water discharges into their separate storm sewer systems. Permits will not be based on end-of-pipe effluent limits like wastewater permits but on the recommendations in the required management. emuent mints make wasteware permits out on the recommendations in the required management plan. By collecting accurate system information and carefully evaluating alternative control methods at the outset, municipal officials can help keep long-term costs to a minimum while ensuring the effectiveness of implemented measures. (Doria-W91-11541

AEROBIC AND ANAEROBIC BIOFILTRATION IN AN AQUACULTURE UNIT--NITRITE
ACCUMULATION AS A RESULT OF NITRIFICATION AND DENITRIFICATION.
Hebrew Univ. of Jerusalem (Israel). Div. of Microbial and Molecular Ecology.
J. van Rijn, and G. Rivera.
Aquacultural Engineering AQEND6, Vol. 9, No.
4, p 217-234, 1990. 8 fig, 4 tab, 26 ref. German
Ministry for Research and Technology joint
German-Israeli Program on Aquaculture NCRD
Project AQ6/533. Project AO6/533.

Descriptors: \*Aerobic treatment, \*Anaerobic digestion, \*Aquaculture, \*Wastewater treatment, \*Nitrites, \*Biological wastewater treatment, Nitrification, Trickling filters, Ammonia, Oxidation, Nitrogen fixing bacteria, Fluidized beds, Wastewater reactors, Biological treatment, Denitrification.

Biological oxidation and reduction of inorganic nitrogen were studied in an aquaculture unit equipped with an aerobic trickling filter and two, anaerobic, fluidized bed columns. The rate of ammonia oxidation in the trickling filter was shown to monia oxidation in the trickling filter was shown to be dependent on the ambient ammonia concentration in the unit, indicating that ammonia oxidation by the nitrifying bacteria was substrate-limited with respect to ammonia. The maximum removal rate of ammonia was 0.43 g NH4-N/sq m/d. Nitrite removal by the trickling filter took place when ambient ammonia concentrations were < 1 mg/L NH4-N, while at higher ambient ammonia centrations nitrite accumulated. The fluidized concentrations intrite accuminated. In mutuated bed columns, employed in the system, were fed with endogenous organic material from the pond. Under these conditions, high specific nitrate removal rates were obtained at relatively short retention times. Nitrate removal, however, fluctuated sharply over a diurnal cycle and nitrite accumulation took place under all running conditions examined. (Author's abstract)
W91-11547

DESIGN AND PERFORMANCE OF THE BIO-FISH WATER RECIRCULATION SYSTEM. Norsk Hydroteknisk Lab., Trondheim B. Eikebrokk.

Aquacultural Engineering AQEND6, Vol. 9, No. 4, p 285-294, 1990. 11 fig.

Descriptors: \*Water reuse, \*Wastewater treatment, \*Water conservation, \*Aquaculture, \*BIOFISH system, \*Recirculated water, \*Water treatment, \*Water supply, Design standards, Performance evaluation, Norway, Fish farming, Aeration, Biological treatment, Filtration, Nitrification, Oxygenation, Trout, Salmon, Water use, Ammonia.

Water is reused in aquaculture due to shortages in water quantity and quality, more stringent effluent quality standards, the need for energy conserva-tion, more intensive production regimes, and a better overall economy. Conventional water recirbetter overall economy. Conventional water recirculation systems are not, however, widely used in Norway, because current production regimes are not able to fully utilize the potential of recirculation systems, and the rather poor reputation of such systems due to complexities in both design and operation. These facts led to the initiation of a project to identify simple alternatives to the conventional water recirculation systems applied in fish farming. A simple intank water treatment and reuse system, called BIOFISH, was designed. The primary unit of the system is a submerged and aerated upflow biofilter, with nitrification and

oxygen transfer as the primary functions. In addition, the biofilter acts as an air lift pump, creating the necessary water circulation flow in the fish tank. Particles are removed from the effluent through a pipe from the tank bottom. The BIO-FISH system has been operated for several months; both with rainbow trout and Atlantic salmon smolt. Results show that water consumption, and thereby the amount of effluent water, can be reduced by 90-95% compared to flow through systems. The oxygen concentration in the fish tank was 5 mg/L or higher, and total ammonia-N concentration never exceeded 1 mg NH4(+)-N/L, even at fish densities as high as 80 kg/cu m. (Author's abstract) W91-11548

ASSESSMENT OF INTERNATIONAL TECHNOLOGIES FOR SUPERFUND APPLICATIONS.

Environmental Protection Agency, Washington, DC. Office of Solid Waste and Emergency Re-

For primary bibliographic entry see Field 5G. W91-11584

### 5E. Ultimate Disposal Of Wastes

LONG CLIMB TO REMEDIATION. For primary bibliographic entry see Field 5G. W91-10483

ENVIRONMENTAL ASSESSMENT OF WASTEWATER MARINE DISPOSAL OF XIAOGANG ZONE, NINGBO.

Tsinghua Univ., Beijing (China). M. Huang, Q. He, Z. Han, H. Chen, and X. Liao. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 443-447, 1991. 1 fig. 3 tab, 2 ref.

Descriptors: \*China, \*Environmental impact, \*Outfall, \*Path of pollutants, \*Wastewater disposal, \*Wastewater treatment facilities, \*Water pollution sources, Agriculture, Dissolved oxygen, Fer-tilizers, Mathematical models, Model studies, Nitrogen, Nutrient concentrations, Runoff, Water movement, Water quality, Water quality standards, Yongjiang River.

The Xiaogang Zone is located in the northeastern part of Ningbo, China. It encompasses an area of 3.9 sq km, and is designed to treat 40,000 cu m/day of wastewater. The mouth of the Yongjiang River is about 600 m from the zone. The average flow of the ebb tide at the river mouth is 520 cu m/sec, including 70 cu m/sec of runoff, which has a direct influence on the water quality of the nearby coast of the Xiaogang zone. The effluent from preliminary treatment is discharged at Changitaozui and distributed evenly into the ocean by diffusers up to 150 m offshore at a water depth of 15 m. Since the 150 m offshore at a water depth of 15 m. Since the nitrogen pollution in this area is rather serious, more consideration should be given to controlling the loss of fertilizer from the land. The allowable water quality concentrations in this area are set to COD-Mn below 4 mg/L and dissolved oxygen greater than 4 mg/L. Water quality models can predict water particle movement and increase of pollutant concentration. (Brunone-PTT) W91-10570

ASSESSMENT OF THE ENVIRONMENTAL CAPACITY OF ENCLOSED COASTAL SEA. Zagreb Univ. (Yugoslavia). Faculty of Civil Engi-S. Tedeschi.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 449-455, 1991. 3 fig, 2 tab, 5 ref.

Descriptors: \*Coastal waters, \*Environmental impact, \*Marine environment, \*Outfall, \*Wastewater disposal, \*Wastewater outfall, \*Water pullution prevention, \*Water quality control, Currents, Decision making, Ecosystems, Estuaries, Gulfs, Lagoons, Water exchange, Water quality standards.

### **Group 5E—Ultimate Disposal Of Wastes**

Wastewater discharge into the coastal sea is treat-ed wastewater, inflowing through coastal or marine outfalls. Three types of discharge site characteristics and the receiving marine environment are considered: the open sea in which strong cur-rents and exchange of the sea water mass exist; a semi-enclosed type (estuary or river mouth an channels, with a satisfactory exchange of sea mass, either due to the difference in salinity or density, or due to the influence of tidal exchange; or an enclosed sea system (lagoon or gulf), with a very limited sea mass exchange with the open sea. The assessment of environmental capacity is one of the tools for decision-making in the selection of measures for sea quality protection in semi-enclosed and enclosed coastal seas. When assessing the environmental capacity, all of the processes affecting the assimilation or accumulation of anthropogenic matter in the marine ecosystem should be taken into account. (Brunone-PTT)

W91-10571 ures for sea quality protection in semi-enclosed and

PROJECT ON SEACOAST OF ENCLOSED COASTAL SEA.

Osaka Bay Center for Regional Offshore Land Reclamation, Bingo-machi 4-1-3, Chuoku, Osaka, 541 Japan.

T. Katayama, and O. Ata.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 669-670, 1991. 3 fig.

Descriptors: \*Coastal areas, \*Japan, \*Waste disposal, \*Water pollution control, Domestic wastes, Enclosed seas, Industrial wastes, Slag, Sludge, Wastewater treatment facilities.

The wastes discharged from Kinki district amount to a hundred million tons a year. Even if measures are taken to promote resource recovery from such wastes and reduce the weight and volume of wastes by intermediate treatment, 46 million tons wastes by intermediate treatment, 46 million tons of wastes must be disposed of in a different way. With plan to prevent further environmental pollution, wastes such as general wastes, industrial wastes, soil discharged by construction activities, and dredged sand from the region will be disposed of in two final disposal sites, off-Amagasaki (113 ha) and off-Izumiotsu (203 ha). An impermeable water-controlled area has been designed where general wastes, such as sewage sludge and slag, are deposited. To prevent water pollution steel sheet piles have been driven in behind the sea wall down to the clay layer and water is discharged through piles have been driven in bening the sea wan down to the clay layer, and water is discharged through the waste water treatment facility to prevent water pollution. (Author's abstract) W91-10594

SEWAGE TREATMENT AND DISPOSAL STRATEGIES IN GREECE. Ministry of Physical Planning, Housing and Envi-

ronment, Athens (Greece).
For primary bibliographic entry see Field 5G.
W91-10598

CONTROL OF ENTERIC MICRO-ORGANISMS BY AEROBIC-THERMOPHILIC CO-COM-POSTING OF WASTEWATER SLUDGE AND AGRO-INDUSTRY SLUDGE.

Hebrew Univ. of Jerusalem (Israel). H. Shuval, R. Jodice, M. Consiglio, G. Spaggiarri,

and C. Spigoni.
Water Science and Technology WSTED4, Vol.
24, No. 2, p 401-405, 1991. 2 fig, 1 tab, 8 ref.

Descriptors: \*Composting, \*Farm wastes, \*Italy, \*Pulp wastes, \*Sludge treatment, Bacterial analysis, Carbon, Cellulose, Fecal coliforms, Fecal streptococci, Fertilizers, Humic acids, Nitrogen, Nutrients, Salmonella, Temperature.

A field-scale, pilot plant study of aerobic thermo-philic co-composting of digested, dewatered wastewater sludge together with ligneous cellulose wastewater studge together with ingerous cellulose residuals from paper mill and wine industries (poplar bark and grape vine stalks) was carried out in northern Italy. Mean temperatures above 55 C were reached after several days and were maintained throughout much of the composting cycle. The minimum recorded temperatures reached 55 C

for a few consecutive days near the beginning of the compost cycle. A decrease in pile temperature after each turning operation was followed by an after each turning operation was followed by an increase. By the end of the complete compost cycle, the concentration of fecal coliforms was reduced from 100,000/g dry matter to 10/gdm. Fecal streptococci were reduced from 1 million/gdm to 100/gdm. Salmonella were reduced to a very low level during the first days of composting and were not detected in a 100 g sample by the 83rd day. The mean C/N ratio of the mixture was reduced during composting from 25 to 17, indicating that complete composting with biological maturity of the materials was achieved. The product of composting was balanced from a nutritive eleof composting was balanced from a nutritive ele-ment aspect. Total humus content was high, conment aspect. Total humus content was high, con-sisting mainly of humic acids, products with long-lasting, slow-release soil fertility properties. Growth tests indicated that the compost had a positive effect on the development and production of crops. (Doria-PTT) W91-10693

NEW DEVELOPMENTS IN PROCESSING OF SLUDGES AND SLURRIES. For primary bibliographic entry see Field 5D. W91-10699

DUTCH APPROACH TO MANURE PROCESS-

Government Agricultural Waste Water Service, Arnhem (Netherlands). For primary bibliographic entry see Field 5D. W91-10703

PROCESSING ORGANIC WASTE PRODUCTS TO BLACK SOIL AND ORGANIC FERTILIZ-ERS.

Rutte Recycling B.V., Amsterdam (Netherlands). J. G. ten Wolde. IN: New Developments in Processing of Sludges and Slurries. Elsevier Science Publishing Co., New York. 1986. p 59-66. 2 fig, 3 tab, 4 ref.

Descriptors: \*Fertilizers, \*Organic wastes, \*Sludge disposal, \*Sludge utilization, \*Soil amendments, \*The Netherlands, \*Waste treatment, Composting, Farm wastes, Land disposal, Quality control, Sludge, Sludge digestion, Sludge stabilization, Sludge treatment.

Processing organic waste products into black soil and organic fertilizers, apart from the possibilities of incineration and dumping, is one of the alternatives for sludge processing. Measures to promote recycling in The Netherlands are stimulated by the government. For economic reasons, recycling merits maximum attention. On the basis of the fertilizer characteristics of purified sludge and other organic waste products (agro-industrial by-products), processing into fertilizer and soil are regarded as possibilities, provided the final product regarded as possibilities, provided the final product meets certain quality criteria. In The Netherlands standards are being developed for the basic soil quality and for organic fertilizers. By combining 'loaded' and 'unloaded' organic waste products, specified qualities of organic fertilizers and black soil are attainable. Black soil is obtained by mixing sandy soils with stabilized organic materials in order to obtain better structural properties for imorder to obtain better structural properties for im-proved growth conditions for landscaping. Stabiliaction of purified sludge takes place on natural drying beds and by composting in covered halls. The final composition is determined on the basis of available data by means of a computer projection. The black soil is applied in various green belt projects and the organic fertilizers are used in agriculture. (See also W91-10699) (Author's abstract) W91-10705

SLUDGE MANAGEMENT BY THERMAL CONVERSION TO FUELS. For primary bibliographic entry see Field 5D. W91-10706

DEVELOPMENT OF RISK ASSESSMENT METHODOLOGY FOR LAND APPLICATION

AND DISTRIBUTION AND MARKETING OF MUNICIPAL SLUDGE.

DC. Office of Research and Development.

Available from the National Technical Information

Available from the National Technical information Service, Springfield, VA. 22161, as PB90-135740. Price codes: A20 in paper copy, A01 in microfiche. Report No. EPA/600/6-89/001, May 1989. 438p, 13 fig. 39 tab, 106 ref, 5 append.

Descriptors: \*Environmental effects, \*Land disposal, \*Municipal wastes, \*Risk assessment, \*Sludge disposal, Data interpretation, Regulations, Sludge, Standards, Waste management,

This is one of a series of reports that present methodologies for assessing the potential risks to humans or other organisms from the disposal or reuse of municipal sludge. The sludge management practices addressed by this series include land ap-plication practices, distribution and marketing proplication practices, distribution and marketing programs, landfilling, incineration and ocean disposal. In particular, these reports provide methods of evaluating potential health and environmental risks from toxic chemicals that may be present in sludge. This document addresses risks from chemicals associated with land application and distribution and marketing of municipal sludge. These proposed marketing of municipal sludge. These proposed risk assessment procedures are designed as tools to assist in the development of regulations for sludge management practices. The procedures are struc-tured to allow calculation of technical criteria for sludge disposal/reuse options based on the potential for adverse health or environmental impacts. The criteria may address management practices (such as site design or process control specifications), limits on sludge disposal rates or limits on toxic chemical concentrations in the sludge. (Author's abstract) W91-10708

APPLICATION OF A HAZARD ASSESSMENT RESEARCH STRATEGY TO THE OCEAN DIS-POSAL OF A DREDGED MATERIAL: OVER-

Environmental Research Lab., Narragansett, RI. J. H. Gentile, G. G. Pesch, and T. M. Dillon. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-134362. Price codes: A02 in paper copy, A01 in microfiche. Report No. EPA/600/D-89/229, 1989. 7p, 5 fig, 4

Descriptors: \*Decision making, \*Dredging wastes, \*Environmental impact, \*Hazard assessment, \*Ocean dumping, \*Waste disposal, Environmental effects, Hazardous wastes, Marine environment, Monitoring, Research priorities, Water pollution

Under the Marine Protection, Research and Sanctuaries Act, the US EPA has responsibility for establishing and applying criteria for reviewing and evaluating permits for dumping wastes into the ocean, and the US Army Corps of Engineers (COE) has responsibility for issuing permits for the disposal of dredged material into the ocean. After several years of operational experience, the EPA and the COE have reexamined the strengths and weaknesses of this remit program and the general weaknesses of this permit program and the general state of the art in sediment testing for the evaluastate of the disposal of dredged material into the marine environment. This paper describes a predic-tive hazard assessment strategy and decision ra-tionale for disposal that can be used as the basis for revisions both in the ocean dumping regulations and in the permitting program. The strategy requires the physical, chemical, and biological characterization of the dredged material and the dumpsite sediment. This characterization provides a sale sealment. This characterization provides a basis for developing a comprehensive, tiered test-ing and analysis program for determining the po-tential environmental exposures and biological ef-fects. The synthesis of the exposure and effects data supports an overall hazard assessment of the potential environmental effects, which in turn, forms the basis for an initial permitting decision. The disposal activity is monitored specifically to verify the prediction of hazard and to support future revisions of the permit requirements. The

### Ultimate Disposal Of Wastes—Group 5E

technical success of this program can be measured by the degree of agreement between the predicted and the measured environmental consequences of the open water disposal of Black Rock Harbor dredged material. Once evaluated, the hazard as-sessment research strategy can be used to provide the conceptual framework and criteria for the technical assessments that are an integral compo-nent of environmental management decisions. (Lantz-PTT) W91-10740

ROLE OF BIOTECHNOLOGY IN THE TREAT-MENT OF GEOTHERMAL RESIDUAL SLUDGES.

Brookhaven National Lab., Upton, NY. Dept. of

Applied Science.
For primary bibliographic entry see Field 5D.
W91-10744

SURFACE DILUTION OF ROUND SUB-MERGED BUOYANT JETS.

Michigan Univ., Ann Arbor. Dept. of Civil Engi-

S. J. Wright, P. J. W. Roberts, Y. Zhongmin, and N. E. Bradley. Journal of Hydraulic Research JHYRAF, Vol. 29, No. 1, p 67-89, 1991. 12 fig, 2 tab, 22 ref.

Descriptors: \*Buoyant jets, \*Hydraulic engineering, \*Hydraulic jump, \*Jets, \*Outfall, \*Wastewater disposal, Flow equations, Flow models, Hydrodynamics, Mathematical analysis, Mixing, Radial flow.

Conventional analyses for estimating dilution within a submerged vertical round buoyant jet as it interacts with a free surface in an unstratified, stagnant receiving fluid generally consider only the mixing due to the rising jet and neglect further dilution in the region where the jet is deflected and begins to spread radially along the surface. A study begins to spread radiany along the surface. A study has been made of the entrainment within a region that typically extends a few flow depths away from the source. This region was analyzed as a radial internal hydraulic jump and computational results indicate dilution increases even greater than results indicate dilution increases even greater than within the submerged jet. Two experimental studies were performed to measure dilution within the radially spreading flow region. The data indicate that the surface dilution directly above the jet can be predicted by allowing for a thin blocking layer at the surface. The data also indicate a three to fivefold increase in surface dilution across the in-ternal jump. Both the analysis and data indicate a hydrodynamic instability for jets with low buoyan-cy that results in the gravitational layer locally mixing over the entire depth with some re-entrain-ment back into the internal jump. (Author's abstract) W91-10986

HYDROGEOLOGIC INFERENCES FROM DRILLERS' LOGS AND FROM GRAVITY AND RESISTIVITY SURVEYS IN THE AMARGOSA DESERT, SOUTHERN NEVADA.

Geological Survey, Denver, CO. W. J. Oatfield, and J. B. Czarnecki. Journal of Hydrology JHYDA7, Vol. 124, No. 1/2, p 131-158, April 1991. 17 fig, 18 ref.

Descriptors: \*Borehole geophysics, \*Geohydrology, \*Geological surveys, \*Geophysical surveys, \*Groundwater movement, \*Nevada, \*Radioactive waste disposal, \*Well logs, Geologic control, Geologic units, Gravity studies, Groundwater barriers, Hydrology, Resistivity, Solute transport, Underground waste disposal.

The Amargosa Desert of southern Nevada, in the Basin and Range geological province, is hydraulically downgradient from Yucca Mountain, the potential site of a repository for high-level nuclear waste. Groundwater flow paths and flow rates beneath the Amargosa Desert are controlled partly by the total saturated thickness and the hydraulic properties of basin-fill alluvial sediments. Drillers' logs of water wells completed in alluvium were analyzed to help desertation. logs of water wells completed in alluvium were analyzed to help characterize the hydrogeologic framework underlying the Amargosa Desert. Frac-

tions of coarse-grained sediments, calculated from tions of course-grained seuments, calculated from each of these logs, were contoured using a universal-kriging routine to interpolate values. Results from a previous electrical sounding survey also were contoured, including the estimated depth to basement rocks. The vertical electric sounding results were obtained from individual depth-to-resistivity profiles, from which the average resistivity of the total profile and the resistivity of the upper 75 m were calculated. The distribution and vari-75 m were calculated. The distribution and variations in regional gravity. Patterns of contours of the resistivity of the upper 75 m of alluvium were similar to patterns of regional contours of the predominant cation (sodium) in groundwater. Gravity lows correspond in some places to the presence of lacustrine, eolian, or marsh surface deposits, which may function as barriers to groundwater flow. Gravity lows also correspond to areas with thick basin-fill sediments, which was corroborated by depth-to-basement data determined from vertical electric soundings. Depths to basement rocks may be as much as 1600 m based on data from the resistivity survey, which were corroborated in part by seismic-refraction survey data. Small variations exist in the percentage of the corroborated in part by seismic-refraction survey data. Small variations exist in the percentage of the basin fill that is saturated. The unsaturated zone is always <15% of the alluvial column. Analysis of depth-to-water and hydrochemical data, in conjunction with average resistivity data for the upper 75 m of alluvium, suggest a hydrologic barrier near the center of the Amargosa Desert. (Author's abstract) W91-10996

EVAPORATIVE DRYING OF DREDGED MA-TERIAL.

Hole, Montes and Associates, Inc., Naples, FL. For primary bibliographic entry see Field 5D. W91-11000

ASSESSMENT OF HYDROGEOLOGIC CONDITIONS WITH EMPHASIS ON WATER QUALITY AND WASTEWATER INJECTION, SOUTHWEST SARASOTA AND WEST CHARLOTTE COUNTIES, FLORIDA. Geological Survey, Tallahassee, FL. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-11087

BIODEGRADATION OF CHEMICALS AT TRACE CONCENTRATIONS. Cornell Univ., Ithaca, NY.
For primary bibliographic entry see Field 5B.
W91-11102

SEWAGE SLUDGE TREATMENT AND USE: NEW DEVELOPMENTS, TECHNOLOGICAL ASPECTS AND ENVIRONMENTAL EFFECTS. Proceedings of a conf. spons. by the Comm. of the European Communities, Directorate-General Science, Resch. and Development; the European Water Pollution Control Asso.; and the Netherlands Asso. on Waste Water Treatment and Water Quality Control, held in Amsterdam, The Netherlands, 19-23 Sept. 1988. Elsevier Science Publishing Co., NY 1989. 536p. Edtd. by A. H. Dirkzwager and P. L'Hermite.

Descriptors: "Biological treatment, "Europe, "In-cineration, "Landfills, "Sludge disposal, "Sludge drying, "Sludge treatment, "Wastewater disposal, "Wastewater treatment," \*Wastewater treatment, Agriculture, Environmental effects, Regulations, Thermal properties.

A new European Community directive due to be implemented soon will make sludge disposal on agricultural land more difficult. When this measure agricultural land more difficult. When this measure is combined with growing objections to sea disposal and the limited possibilities for landfilling, alternative avenues of disposal for the growing quantities of sewage sludge are increasingly more important. Greater use of incineration is a possible suitable route. Other possibilities are agricultural use of sewage sludge, sludge dewatering and biological conditioning, and other thermal processes. Other topics discussed are sludge characterization and quality aspects. (See W91-11116 thru W91-11161) (Brunone-PTT)

W91-11115

PRODUCTION, TREATMENT AND HANDLING OF SEWAGE SLUDGE.

Water Research Centre, Medmenham (England). For primary bibliographic entry see Field 5D. W91-11116

PHYSICAL AND CHEMICAL CHARACTER-IZATION OF SEWAGE SLUDGE.

Institut de Recherches Hydrologiques, Nancy (France). For primary bibliographic entry see Field 5D. W91-11117

SLUDGE REDUCTION POSSIBILITIES AS DEMONSTRATED BY THE CHEMOLYSIS PROCESS DOW STADE GMBH.

Wasserwirtschaft Stade (Germany, F.R.). For primary bibliographic entry see Field 5D. W91-11118

METHODS OF APPLYING SEWAGE SLUDGE TO LAND: A REVIEW OF RECENT DEVELOP-MENTS.

Water Research Centre, Medmenham (England). J. E. Hall.

J.E. Tail. IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 65-84. 4 fig. 7 tab, 64 ref.

Descriptors: \*Agricultural practices, \*Land disposal, \*Sludge, \*Sludge disposal, \*Waste disposal, \*Wastewater treatment, Aerosols, Disease transmission, Economic aspects, Environmental effects, Monitoring, Odors, Soil physical properties.

The methods which the sewage sludge disposal authorities use to spread sludge on farmland must avoid environmental problems, provide service to farmers, and be cost-effective. Selection of the correct equipment and good business practices is essential to the longterm security of the agricultur-al outlet for sewage sludge disposal. However, all other for sewage studge usposa. Towever, studge spreading is still the major source of public complaint when compared with other aspects of sewage treatment. These complaints are due principally to real or perceived odor, and other environments. mental concerns relating to specific methods of sludge spreading, particularly the potential for disease transmission by aerosols, and ammonia volatilization with its potential impact on global soil acidification. Farmers are becoming increasingly acidification. Farmers are becoming increasingly aware of potential problems of soil structural damage through the use of heavy sludge spreading vehicles and the difficulty of spreading sludge evenly and at the target application rate, which has implications for crop response and soil monitoring. The cost-effectiveness of sophisticated equipment depends upon local operating conditions, however, not all of the developments in equipment design are of high cost and these may well be considered by the sludge disposal authorities. (See also W91-11115) (Brunone-PTT) W91-11119

ALTERNATIVE USES OF SLUDGE OTHER THAN AGRICULTURAL.

Water Research Centre, Unit 16, BETA Centre University, Stirling Innovation Park, Stirling, FK9 4NF, Scotland.

C. D. Bayes, E. Vigerust, and B. Paulsrud.

In: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 85-101. 3 fig, 5 tab, 30 ref.

\*Forestry, \*Sluage, Descriptors: \*Fertilizers, \*Forestry, \*Sludge, \*Sludge disposal, \*Sludge utilization, \*Soil amend-ments, \*Waste disposal, \*Wastewater treatment, Cost analysis, Land reclamation, Nitrogen, Nutrient concentrations, Organic matter, Physical properties, Pollution control, Resources management, Runoff, Urban areas, Water resources management

### Group 5E-Ultimate Disposal Of Wastes

Four options are considered for utilizing sewage sludge on forest land as a resource, rather than in agriculture. Within the forestry cycle the follow-ing uses have been determined: as a soil condition er for the restoration of disturbed soils, as a soilforming material for reclaiming disturbed soils, as a soil-forming material for reclaiming derelict land, and for producing soil for use on green areas in the urban environment. The characteristics of the sludge, particularly organic matter, nitrogen re-lease, physical properties and hygienic status, are lease, physical properties and hygienic status, are modified by treatment and must be appropriate to the end use. To successfully exploit the resource potential of sewage sludge requires planning, management and cost-effective transport and applica-tion of the sludge. Planning is necessary for the tion of the studge. Planning is necessary for the protection of water resources, such as avoiding private supply catchments in forests, and the coordination of sludge production/storage with irregular/spasmodic demand as in reclamation schemes. Application rates and timing must be schemes. Application rates and timing must be appropriate for the site conditions to avoid polluting runoff. Sludge application methods may differ from those appropriate for agricultural use and may require the development of new equipment or working methods. (See also W91-11115) (Brunone-DTT). PTT) W91-11120

MODERN SLUDGE MANAGEMENT: THE MANAGER'S CHOICE.

European Water Pollution Control Association, Markt 1, D-5205, Sankt Augustin,,G Germany. For primary bibliographic entry see Field 5D. W91-11122

PATHWAY ANALYSIS OF SELECTED OR-GANIC CHEMICALS FROM SEWAGE TO AG-RICULTURAL SOIL.

Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Due-bendorf (Switzerland).

For primary bibliographic entry see Field 5B. W91-11123

ORGANIC SUBSTANCES IN SOILS AND PLANTS AFTER INTENSIVE APPLICATIONS OF SEWAGE SLUDGE,

Landwirtschaftliche Untersuchungs- und Fors-chungsanstalt, Speyer (Germany, F.R.). W. Kampe.

N: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 180-185. 2 tab, 3 ref.

Descriptors: \*Bioaccumulation, \*Path of pollut-ants, \*Polychlorinated biphenyls, \*Sudge disposal, \*Soil amendments, \*Soil contamination, \*Wastewater treatment, \*Water pollution sources, Agriculture, Crops, Vegetation.

Soil and plant samples from several locations in Germany were analyzed in a joint project with samples from trials with dressings of sewage sludge between 1959 and 1980. Chlorinated hydrocarbon did not accumulate in the soils or transfer to plants. did not accumulate in the soils of transfer to plants. Polychlorinated biphenpls increased on an average 5-fold to 17-fold and polycyclic compounds 5-fold and 10-fold after application of sewage sludge. No regular transfer to crop plants was detectable, where the order of magnitude was in the microg/kg range. The results showed, with a high degree of certainty, that the organic substances investigated do not need to be limiting factors for the use of sewage sludge in agriculture. (See also W91-11115) (Author's abstract) (Author's abstract) W91-11126

HIGH-PRESSURE DEWATERING WITH POLYMER CONDITIONING AS A PREREQUI-SITE FOR THE ENERGY-INDEPENDENT IN-CINERATION OF SEWAGE SLUDGE.

Abwasser-Abfall-Aquatechnik, Darmstadt (Germany, F.R.).

For primary bibliographic entry see Field 5D. W91-11127

SLUDGE DEWATERING TECHNOLOGY IN PERSPECTIVE.
KHD Humboldt Wedag A.G., Cologne (Germany,

F.R.).

For primary bibliographic entry see Field 5D W91-11128

TECHNICAL REQUIREMENTS AND POSSI-BILITIES OF INCINERATION. For primary bibliographic entry see Field 5D. W91-11129

ENVIRONMENTAL ASPECTS OF SLUDGE IN-CINERATION: OVERVIEW, Kernforschungszentrum Karlsruhe G.m.b.H. (Ger-

many, F.R.). W. Robel, and K. U. Rudolph.

w. Robel, and K. U. Rudoiph.

IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p. 236-251. 5 fig. 7 tab, 28 ref.

Descriptors: \*Environmental effects, \*Incineration, \*Sludge disposal, \*Sludge treatment, \*Soil contamination, \*Wastewater treatment, Air pollution, Dioxins, Furans, Heavy metals, Organic matter, Regulations, Residence time, Temperature.

The amount of sewage sludge and the problems with disposal are increasing. Because of the decreasingly available areas for ultimate disposal and use in agriculture (possible contamination with organic substances and heavy metals), the inciner-ation of sewage sludge will receive more impor-tance. Quantitative data on the formation of diox-ins and furans for sludge incineration are limited. ins and turians of studge incineration are infinited. The formation of these compounds in studge incineration plants is lower than the emissions from incineration of municipal waste, the emission of dioxins and furans are normally lower than the legislative limit values. The formation of dioxins registative limit values. In elormation of dioxins can be reduced by the process condition in the incinerator or by addition of lime to the incineration process. Dioxins and furans are found primarily in the fly ashes and gases. Minimization of these my in the fly saines and gases. Millimization of these emissions can be achieved by high burn out of the fly ash, low copper content, and low residence time of fly ash in critical temperature zones. (See also W91-11115) (Brunone-PTT) W91-11130

SEWAGE SLUDGE INCINERATION AND UTI-

LIZATION OF ENERGY. BASF A.G., Ludwigshafen am Rhein (Germany, F.R.).

For primary bibliographic entry see Field 5D. W91-11131

STATUS REPORT ON ENVIRONMENT CAN-ADA'S OIL FROM SLUDGE TECHNOLOGY. Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre. For primary bibliographic entry see Field 5D. W91-11133

INFLUENCES ON THE MECHANICAL PROP-ERTIES OF SEWAGE SLUDGE FOR DISPOS-AL TO LANDFILL.

Ruhr Univ., Bochum (Germany, F.R.). Lehrstuhl fuer Wasserwirtschaft und Umwelttechnik II. For primary bibliographic entry see Field 5D. W91-11135

ENVIRONMENTAL ASPECTS OF LANDFILL-ING SLUDGE.

Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). Lab. of Waste Materials and Emissions. D. Beker.

D. Beker. IR: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 325-336. 4 fig. 6 tab, 7 ref.

Descriptors: \*Landfills, \*Leachates, \*Path of pollutants, \*Sludge disposal, \*Sludge treatment, \*The

Netherlands, \*Wastewater treatment, Chemical oxygen demand, Heavy metals, Hydrogen ion con-centration, Sludge drying.

The total quantity of sludge produced in the Netherlands is about 400,000 tons dry matter, of which about 25% is landfilled. Normally, sludge is landfilled together with other wastes. In a survey of 30 existing landfill sites, the quantity of sludge being landfilled does not exceed 10% of total waste composition. An effect of sludge on leachate quality could not be found with regard to heavy metals and some classical parameters (COD, Cl, etc.). Due to the relative low contribution of polluting components from sludge to the total quantity of polluting components in the landfilled waste, a major influence was not to be expected. Sludge polluting components in the landfilled waste, a major influence was not to be expected. Sludge was applied to other wastes in larger quantities (24%, with 38% dry matter). Sludge did have an influence on the leachate quality, i.e. lower COD and volatile fatty acids (VFA) concentration and higher pH. As a result of the higher pH value, heavy metal concentrations were diminished. In the long-term, the difference will probably disappear, and COD, VFA and pH will be equal after stabilization. (See also W91-11115) (Author's abstract) stract) W91-11136

SLUDGE RECYCLING IN AGRICULTURE COMPARED WITH OTHER DISPOSAL METHODS IN FRANCE,

Department of Water and Pollution and Hazard Avoidance, Ministry of the Environment, France. F. Chalot, and P. Guettier.

IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 347-351.

Descriptors: \*Agriculture, \*France, \*Landfills, \*Regulations, \*Sludge disposal, \*Sludge treatment, \*Sludge utilization, \*Wastewater treatment, Com-parison studies, Heavy metals, Sludge drying.

Agricultural use of sewage sludge is a priority of French disposal policy. With estimated current production of 600,000 tons dry matter per year, the production of 000,000 tons ory matter per year, the proportion used in agriculture has increased from 20 to 30%, to 40 to 50% over the last ten years while landfilling has declined. In particular, the various constraints (heavy metal contamination, low dry matter content, etc.) are now relevant to low dry matter content, etc.) are now relevant to every sludge disposal option (agricultural use, landfilling, incineration). The true costs of disposal must increasingly be paid; actions must be taken to enable the full potential of agricultural use to developed; and effective solutions have to be tai-lored to individual cases and should be more closely adapted to the local context. The application of sludge to agricultural land in liquid form will probsludge to agricultural land in liquid form will prob-ably remain the best solution in both practical and economic terms for the great majority of small sewage treatment plants. The medium and large plants will develop solutions based on improved complementarity, depending on local constraints and opportunities: between sludge treatment and final disposal; between different sludge disposal options; and between disposal of sludge and of other wastes. (See also W91-11115) (Brunone-PTT) PTT W91-11137

USE OF MUNICIPAL SEWAGE SLUDGE IN AGRICULTURE; THE ROLE OF THE WATER AUTHORITIES.

Pollution Control Department, ARTOIS-PICAR-For primary bibliographic entry see Field 5D. W91-11138

EXAMPLES OF AGRICULTURAL USE OF RESIDUAL SLUDGE.

For primary bibliographic entry see Field 5D. W91-11139

SLUDGE TREATMENT AND TIPPING SITE 'HARTELMOND'.

### Ultimate Disposal Of Wastes-Group 5E

Hollandse Eilandenen Waarden Wastewater Authority, Dordrecht (Netherlands). For primary bibliographic entry see Field 5D. W91-11140

BAN ON PHOSPHORUS IN DETERGENTS: THE EFFECTS ON THE PHOSPHORUS CON-TENTS OF SWISS SEWAGE SLUDGES AND ON THE EFFICIENCY OF PHOSPHORUS ELIMINATION BY SEWAGE TREATMENT

Eidgenoessische Forschungsanstalt fuer Agrikul-turchemie und Umwelthygiene, Bern (Switzerland).

For primary bibliographic entry see Field 5D. W91-11142

AEROBIC-THERMOPHILIC METHODS FOR DISINFECTING AND STABILIZING SLUDGE. Fuchs Gastechnik and Wassertechnik G.m.b.H.,

Mayen (Germany, F.R.). For primary bibliographic entry see Field 5D. W91-11143

EXTRACTION OF HEAVY METALS FROM SLUDGES AND MUDS BY MAGNETIC ION-EXCHANGE

Commonwealth Scientific and Industrial Research Commonweath Scientific and Industrial Research Organization, Melbourne (Australia). Div. of Chemicals and Polymers. For primary bibliographic entry see Field 5D. W91-11145

WET OXYDATION AS THE ALTERNATIVE FOR SEWAGE SLUDGE TREATMENT. GRONTMIJ N.V., De Bilt (Netherlands). For primary bibliographic entry see Field 5D. For primary W91-11146

MODIFICATIONS OF SOME PHYSICAL PROPERTIES IN TWO COMPOST-AMENDED ITALIAN SOILS.

Consiglio Nazionale delle Ricerche, Pisa (Italy).

Ist. di Chimica Terreno. G. V. Guidi, R. Pini, and G. Poggio.

G. V. Outdi, K. Pini, and G. Poggio. IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 427-432. 2 fig, 2 tab, 4 ref.

Descriptors: \*Composting, \*Fertilizers, \*Italy, \*Sludge disposal, \*Soil amendments, \*Soil physical properties, \*Wastewater treatment, organic matter, Soil chemistry, Soil porosity.

Two field experiments were conducted in which different rates of composts were compared with farmyard manure and mineral fertilizers. Dressings rarmyard manure and mineral tertifizers. Dressings were applied yearly in one case on the basis of available nitrogen (100 kg/ha, 200 kg/ha, and 300 kg/ha) and in the second case on organic matter (15 tons/ha and 40 tons/ha). Large seasonal variations were found for water stability index and ations were found for water stability index and porosity. The effects of composts were similar to those of manure or sometimes higher, at corresponding rates. The addition of organic materials did not always improve soil physical characteristics immediately. Soil structural improvements were always related to the addition of organic matter. Crushed glass present in composts accumulated in the plough layer. The two soils different reactions to the repeated additions of high amounts of organic matter was probably due to physical parameters related to soil structure which could have been influenced more by inorganic binding agents than by the organic ones. In addition, some external physical stresses, such as rain, could have played a role in the mechanisms which regulate the played a role in the mechanisms which regulate the formation and the maintenance of soil pores of a given radius. (See also W91-11115) (Brunone-PTT) W91-11148

COMPOSTING RAW SEWAGE SLUDGE IN COMPOSTING RAW SEWAGE SLUDGE IN THE ABSENCE OF BULKING AGENTS.
Istituto di Microbiologia Agraria e Stazione de Microbiologia Industriale, Portici (Italy).
S. Coppola, F. Villani, and F. Romano.

IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 433-439. 4 fig. 3 tab.

Descriptors: \*Composting, \*Sludge disposal, \*Sludge utilization, \*Wastewater treatment, Aero-bic digestion, Disinfection, Dry matter, Organic matter, Sludge filters, Sludge stabilization.

The availability of organic solid waste materials has resulted in the composting of dewatered sewage sludges by closed or windrow systems with forced or spontaneous aeration. A new method of aerobic stabilization for the solid state of method of aerobic stabilization for the solid state of raw sewage sludge in the form of filter cake (20% to 22% of dry matter) has been developed that does not require bulking agents or mixing with other organic solids. These additives were neces-sary to overcome physical barriers to self-heating due to the high water content and to the low due to the high water content and to the low carbon-nitrogen ratio. In the new method the sludge is treated in a rotary tank supplied with pure oxygen, and the sludge quickly reaches (<12 hours) sanitizing temperatures (>60 C). Microbiological changes occurring during the process that are particularly important are sludge conditioning, sludge stabilization and disinfection. (See also W91-11115) (Author's abstract)

USE OF SEWAGE SLUDGE ON AGRICULTURAL LAND: IMPACT ON SOIL FAUNA.
Neuchatel Univ. (Switzerland). Inst. of Zoology.
A. Ducommun, and W. Matthey.
IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 440-444. 6 fig. 1 tab. 4 ref.

Descriptors: \*Agriculture, \*Fertilizers, \*Sludge disposal, \*Sludge utilization, \*Soil organisms, \*Soil physical properties, \*Wastewater treatment, Comparison studies, Cultivation, Decomposers, Invertebrates, Soil fertility, Species diversity.

Soil fauna maintain the long-term fertility of inten-Soil launa maintain the long-term fertility of intensively cultivated land. The pedofauma contribute to the humification of organic matter and the preservation of soil structure. Therefore, knowledge of the reaction of soil fauna to the application of sewage sludge as fertilizer is essential. The impact of liquid sewage sludge (LSS) was tested on macroinvertebrates between 1983 and 1986 using a variety of applications to humus-rich soils: LSS only, manure only, LSS and manure mixture, and only, manure only, LSS and manure mixture, and mineral fertilizers. Approximately 190,000 macroinvertebrates were captured and identified. The results show that LSS has an overall enrichment effect on the soil fauna; the decomposers, particularly the Diptera, benefit both in species richness and overall abundance. The increase in the numbers of decomposers (as potential prey) benefits the predator and parasite communities. The LSS plus manure mixture is the best treatment since both microdecomposers and macrodecomposers benefit. (See also W91-11115) (Brunone-PTT) W91-11150

EFFECTS OF SEWAGE SLUDGE AND WASTE COMPOST ON SOME SOIL ENZYMATIC ACTIVITIES TESTED IN A FIELD EXPERIMENT. Landwirtschaftlich-chemische Bundesanstalt, Linz

(Austra).

K. Aichberger, and R. Ohlinger.

IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 445-450. 3 fig, 3 tab, 8 ref.

Descriptors: \*Composting, \*Enzymes, \*Sludge disposal, \*Soil chemistry, \*Waste disposal, \*Wastewater treatment, Biomass, Carbon, Fertilization, Nutrient concentrations, Organic matter, Soil respiration.

In a field trial the effect of several year's application of heavy metal contaminated sewage sludges and waste composts was tested on some soil enzy-matic parameters. During the test period, high rates of organic matter, nutrients up to more than

1000 kg/ha and variable amounts of heavy metals were supplied. Mostly soil respiration, biomass carbon, dehydrogenase and protease activity were increased by waste application. No effects were noted for glucosidase and urease activity and phosphorus was depressed on the highest waste-treated plots. Altogether, sewage sludge and waste compost fertilization improved the soil enzymatic activities in 41% of all observations (n=234), but had no effect for 51% and depressed activities in only no effect for 51% and depressed activities in only 8% of all cases. (See also W91-11115) (Author's abstract) W91-11151

EXISTING CONDITIONS FOR AGRICULTUR-AL UTILIZATION OF SEWAGE SLUDGE COMPOST IN JAPAN.

Japan Sewage Works Agency, Tokyo. Research and Technology Div.

In: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 451-463. 3 fig. 4 tab.

Descriptors: "Agriculture, "Compost marketing, "Composting, "Fertilizers, "Heavy metals, "Japan, "Sludge disposal, "Sludge utilization, "Wastewater treatment, Marketing, Odors, Questionnaires, Soil amendments, Workability.

To obtain basic data for formulating the marketing strategy of sewage sludge compost, a macroscopic study of competing fertilizers has been conducted with respect to their production, consumption and marketing. Outputs of the soil conditioners and compost (which accounts for the greater part of special fertilizers) are growing in recent years. Commercial compost which has fertilizing and soil Commercial compost which has retrilizing and soil conditioning effects will be the most likely competition. The position of sewage sludge compost has been identified in the market and promoting strategies have been planned. Four areas differing in climate and farming structure were selected for the climate and farming structure were selected for the survey. The questionnaire survey on the evaluation of sewage sludge compost and buying intentions of users showed that low price is important. The upper retail price limit for a 20 kg bag of sewage sludge compost seemed to be about 500 yen. Complaints were made about workability and odor. Sewage sludge compost should be available in pelleted forms or enriched with additives to differentiate it from other fertilizers. (See also W91-1115) (Authors) extends. 11115) (Author's abstract) W91-11152

PRODUCTION OF COMPOST FROM SEWAGE SLUDGE IN TOKYO. Tokyo Sewerage Bureau (Japan).

M Saika

M. Saika. In: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 464-472. 8 fig. 2 tab.

Descriptors: \*Composting, \*Incineration, \*Japan, \*Landfills, \*Sludge disposal, \*Sludge drying, \*Sludge treatment, \*Sludge utilization, \*Waste disposal, \*Wastewater treatment, Agriculture, Fermentation, Horticulture, Land disposal, Soil amendments, Urban planning.

The present sewerage service rate in Tokyo is 82%. The treated effluent averages about 5,050,000 cubic m, which results in approximately 114,000 cubic m of sludge each day. The sludge is dewatered and mostly incinerated and finally disposed of in landfill. With urbanization, sites for landfill have become difficult to find. To solve this prob-lem, the Tokyo Metropolitan Government has lem, the Tokyo Metropolitan Government has been conducting a variety of research project and experiments. A pilot plant for composting was constructed to find practical measures of sewage studge utilization at Minamitama Wastewater Treatment Plant in 1977. After two years of pilot plant study, a full-scale plant was constructed, which has been operating since 1980, with four transversal fermentation tanks and a stirring-turning machine. The plant has the capacity of producing 3 tons of compost a day from 8 tons of sludge.

### Group 5E-Ultimate Disposal Of Wastes

As no additive is needed, the mass of sludge does not increase in size. The fermenting process takes only 10 days. Produced compost is effective not only as a nitrogen fertilizer but also as a soil conditioner. When the compost came onto the market in 1980, farmers bought most of it, but horticulture has now increased the demand. (See also W91-11115) (Author's abstract)

BENEFICIAL UTILIZATION OF INCINERATED ASH AND MELTED SLAG. Public Works Research Inst., Tokyo (Japan).

Y. Ohshima.

Onsnima.
 Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 473-492. 11 fig. 10 tab, 3 ref.

Descriptors: \*Incineration, \*Japan, \*Sludge disposal, \*Sludge treatment, \*Sludge utilization, \*Wastewater treatment, Cost analysis, Economic aspects, Land disposal, Land reclamation, Sludge thickening.

Sewage sludge production in Japan was about 1.2 million tons in terms of dry solids per year in 1985, which is equivalent to about 75 g per capita per day. Sludge production has been increasing by more than 50,000 tons per year, corresponding to the construction of new wastewater treatment facilities throughout Japan. Most of the sludge is currently disposed of in Jandfills, including constal currently disposed of in landfills, including coastal land reclamation, but suitable sites for landfill are land reclamation, but suitable sites for landfill are becoming increasingly difficult to find, especially around large cities. Reduction of the sludge volume to be disposed, therefore, is a primary concern. About 55% of the sewage sludge in Japan is currently incinerated while melting processes are being scrutinized for reduction of volume for dis-posal and the utilization of melted slag. Utilization of the sewage sludge, including incinerated ash and melted slag for beneficial nurposes is another melted slag for beneficial purposes is another avenue of research. Utilization of incinerated ash and melted slag will greatly reduce the total cost of sludge treatment and disposal. (See also W91-11154 (Author's abstract)

SLUDGE STUDIES ON SLUDGE MANAGE-MENT: STRATEGIC STUDIES ON SLUDGE. Witteveen and Bos, Deventer (Netherlands).
For primary bibliographic entry see Field 5D.
W91-11156

STUDIES FOR A SIMULTANEOUS USE OF LIQUID MANURE AND SEWAGE SLUDGE. Bayerische Landesanstalt fuer Bodenkultur und Pflanzenbau, Munich (Germany, F.R.).

A. Wurzinger, and A. Suss.

IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 499-503. 11 tab.

Descriptors: \*Fertilizers, \*Nitrogen, \*Path of pol-lutants, \*Phosphorus, \*Sludge disposal, \*Sludge treatment, \*Soil amendments, \*Wastewater treat-ment, Agriculture, Cost analysis, Groundwater pollution, Leaching, Manure, Nutrient concentra-tions.

Sewage sludge and liquid manure have high nitro-gen and phosphorus contents. Therefore, their use in agriculture can lead to nitrate problems in groundwater. Since the use of sewage sludge on land is the best disposal method, a combination of both sludge and manure could be a solution. In studies using a variety of plants and soil types only 50% of the total nitrogen was effectively utilized by the plants; the water soluble phosphorus was fully available, the organically bound phosphorus only partly; and the potassium was water-soluble in all three liquid manures. When liquid manure is applied, the amount of nitrogen is limited because of nitrate leaching. After consideration of all the aspects of a combination approach, fertilizing with a mixture of liquid manure and sevence shote is a mixture of liquid manure and sewage sludge is less desireable from the financial aspect, but better from an ecological perspective. The concentration

of plant nutrients in a mixture of liquid manure and odge is not optimal for all plants, but may be pplemented by specific mineral fertilizers. (See so W91-11115) (Brunone-PTT)

DEVELOPMENTS IN SAMPLING

SLUDGE TREATED SOILS.
Water Research Centre, Medmenham (England).

For primary bibliographic entry see Field 5A. W91-11158

CHEMICAL PROPERTIES OF SEWAGE SLUDGES PRODUCED IN THE VALENCIAN AREA (SPAIN).

Instituto Valenciano de Investigaciones Agrarias,

Valencia (Spain).
For primary bibliographic entry see Field 5A.
W91-11159

MICROBIAL BIOMASS AND BIOLOGICAL ACTIVITIES IN AN ACID SANDY SOIL TREATED WITH SEWAGE SLUDGE OR FARMYARD MANURE IN A LONG TERM FIELD EXPERIMENT.

FIELD EXPERIMENT.
Institut National de la Recherche Agronomique,
Bordeaux (France). Station d'Agronomie.
Inieres, R. Chaussod, C. Juste, and P. Solda.
IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co.,
New York. 1989. p 517-520. 1 fig, 3 tab, 5 ref.

Descriptors: \*Biomass, \*Manure, \*Sludge disposal, \*Sludge utilization. \*Soil amendments, \*Soil chem-Descriptors: "Blomass, "Manure, "Sludge disposal, "Sludge utilization, "Soil amendments, "Soil chemistry, "Wastewater treatment, Decomposing organic matter, Microorganisms, Mineralization, Organic matter, Soil properties, Wastewater disposal.

Physicochemical and biological measurements have been taken on soil samples from a long term field experiment in France on an acid coarse sandy soil to confirm and explain the intensive loss of a sludge organic matter added at moderate rates (10 tons/ha/year). The comparison between the farm yard manure (FYM) application and sewage sludge (SS) application showed that sludge is more readily mineralized, while the FYM treatment is able to sustain a high microbial biomass for a long time. The SS addition induced a higher increase in biological activities in the first stages of decomposion, but this stimulation was more transient than r FYM. This phenomena is probably due as much to the light textured soil and climatic influmuch to the ignt textured soil and climate intui-ences (more conducive to mineralization than to humification) as to the effect of the sludge bio-chemical composition on the microbial biomass size and activities. (See also W91-11115) (Brunone-PTT) W91-11160

SLURRY AND SLUDGE SPREADING METH-

Johnstown Castle Research Centre, Johnstown (Ireland). P. V. Kiely.

Pr. V. Mely.

IN: Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. Elsevier Science Publishing Co., New York. 1989. p 521-522.

Descriptors: \*Fertilizers, \*Nitrogen, \*Sludge utilization, \*Slurries, \*Soil amendments, \*Wastewater treatment, Bandspreading, Comparison studies, Experimental design, Shallow injection, Splashplates.

Average cattle and pig slurry contains 4 to 4.5 kg N/ton. The efficiency of utilization of slurry N and sewage sludge N, compared with fertilizer N, has been found to be affected by weather conditions at spreading, the degree of dilution of the slurry with water, the rate of slurry application, and the amount of grass cover. The efficiency of slurry spreading methods on slurry N utilization by gradland was determined in randomized block fie experiments with six replications. Methods compared were the normal splashplate method, shallow injection, and bandspreading. The splashplate method produced little response. High yields of silage dry matter were obtained from shallow in-jection and bandspreading slurry applications. The bandspreading method was superior to the shallow injection method on permanent pasture. Bands-preading also requires little additional equipment. (See also W91-11115) (Brunone-PTT) W91-11161 method produced little response. High yields of

RETURNABLE PESTICIDE CONTAINERS: MAINE'S DEPOSIT AND COLLECTION MAINE'S SYSTEM.

For primary bibliographic entry see Field 5G. W91-11191

OREGON PESTICIDE CONTAINER INITIA-

Oregon Agricultural Chemical Association, Salem. L. Stepher

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 311-326.

Descriptors: \*Hazardous waste disposal, \*Landfills, \*Nonpoint pollution sources, \*Oregon, \*Pesticides, \*Regulations, \*Solid waste disposal, \*State jurisdiction, \*Waste disposal, \*Water pollution control, Administrative agencies, Education, Pestication, \*Control agencies, Education, \*Pestication, \*P cide containers, Recycling, Safety.

In 1984 the Oregon Agricultural Chemicals Asso-ciation (OACA) began to develop a program for the collection of used pesticide containers. The program was called the Oregon Pesticide Contain-er Initiative. The overall objective of this effort was to develop a simple program which took empty containers out of circulation thus preventing reuse or open storage. Initially the program was funded by the National Agricultural Chemical Association but in ensuing years it has been managed by the OACA and funded by that group. In order by the OACA and funded by that group. In order to make the program work a Chairperson and a Committee were needed who would educate growers regarding proper disposal, man receiving stations, and donate time and equipment. The Oregon Department of Environmental Quality developed the legal framework and procedures that would be used in the program. The program also required recyclers who would handle the containers and maintain strict control of those containers until they were disposed of Growers also needed. until they were disposed of. Growers also needed to recognize the hazard and potential liability of to recognize the hazard and potential liability of improperly stored pesticide containers. The program involved three main areas: education, collection, and disposal/recycle. Growers were instructed in the use of good triple rinse and container preparation techniques. Collection of the containers required dedication by a large number of volunteers. Collection sites were provided by local dealers. Dumpsters or lined trucks are used to collect the containers. Finally, all containers go to a recycler. Scripter Steel a power separator or a a recycler, Scnitzer Steel, a power generator, or a landfill. In one year, 92% of the containers were recycled or used for power generation. (See also W91-11162) (Korn-PTT) W91-11192

MINNESOTA WASTE PESTICIDE COLLEC-TION PILOT PROJECT.

L. Palmer.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 327-331, 4 tab.

Descriptors: \*Hazardous waste disposal, \*Minne-sota, \*Nonpoint pollution sources, \*Pesticides, \*Waste disposal, \*Water pollution control, Costs, Feasibility studies, Landfills, Solid waste disposal,

In 1987 the Minnesota State Legislature funded a In 1987 the Minnesota State Legislature tunged a waste pesticide collection pilot study because of growing concern about the difficulties associated with the proper disposal of waste pesticides. The goals of the pilot study included an assessment of the types and quantities of waste pesticides cur-rently in the state, the collection and proper dis-

### Ultimate Disposal Of Wastes-Group 5E

posal of waste pesticides through temporary col-lection sites, and the definition of short and long term waste pesticide management needs. The project was implemented in two phases. The first phase consisted of a statewide mail survey directed project was implemented in two phases. The first phase consisted of a statewide mail survey directed at pesticide dealers, farmers, and user/applicators. The overall response rate was 77% which implied that the target audience thought the issue important enough to respond. The second phase of the pilot study involved the actual waste pesticide collections. A total of 5 individual waste pesticide collections were held with assistance from the local community. While some of the collections were free, others included fees to help pay the cost of disposal. The collection process allowed for the solids to be lab packed and the liquids consolidated. The empty containers generated from the consolidation of liquids were triple rinsed with the rinsate being managed as a hazardous waste, and the rinsed containers being disposed of as solid waste at local landfills. The pilot study proved to be a success and current plans include the preparation of recommendations and strategies that address the management of waste pesticides including both the historical problem and alternative actions for the prevention of future accumulations. (See also W91-11162) (Korn-PTT)

## URBAN PESTICIDE WASTE MANAGEMENT: STRATEGIES FOR EDUCATION AND COL-

LECTION.

S. M. Ridgley.

IN: Agrichemicals and Groundwater Protection:
Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 333-339, 1 tab, 10 ref.

Descriptors: \*Hazardous waste disposal, \*Minnesota, \*Nonpoint pollution sources, \*Pesticides, \*Urban areas, \*Waste disposal, \*Water pollution control, Cost sharing, Education, Feasibility studies, Public participation, Regulations, Surveys.

As a result of concerns about public health and environmental fate of waste pesticides and other household hazardous waste, a number of programs have been developed around the country. Since the fall of 1985 the Minnesota Pollution Control Agency (MPCA) has been conducting a household hazardous waste (HHW) collection and education program. Initially a nitot study was undertaken in program. Initially a pilot study was undertaken in which 14 collection projects were conducted. Detailed inventories were conducted at the pilot coltailed inventories were conducted at the pilot col-lection projects, resulting in valuable information concerning the types and quantities of HHW being stored in Minnesota homes. Pesticides were a common waste, although in comparison to paint and used oil the total volumes were much lower. The primary result of the pilot project was a piece of legislation passed in 1987, which authorized the MPCA to set up a permanent HHW program. The HHW program is responsible for the development and distribution of educational and technical mate-rials, including, general public information, and inand distribution of educational and technical mate-rials, including general public information and in-formation targeted towards specific audiences, such as children. In addition, the HHW program is also responsible for the development and operation of HHW collection sites, including support for one-day collection projects, as well as the estabishment of permanent, ongoing facilities. The MPCA'a HHW program is designed to be an investment in prevention. The responsibility for the management of these wastes lies jointly with the state and the local units of government. Therefore, costs are split 50/50. Ultimately, the responsibility for waste management lies with the average citizen-hence, the program's emphasis on education and waste reduction techniques. (See also W91-11162) (Korn-PTT) W91-11194

PESTICIDE RINSEATE MANAGEMENT

For primary bibliographic entry see Field 5G. W91-11195

WASTE DISPOSAL FACILITIES AND COM-MUNITY RESPONSE: TRACING PATHWAYS FROM FACILITY IMPACTS TO COMMUNITY

Alberta Univ., Edmonton. Dept. of Civil Engineering.

C. Zeiss, and J. Atwater.

Canadian Journal of Civil Engineering CJCEB8, Vol. 18, No. 1, p 83-96, February 1991. 4 fig, 8 tab,

Descriptors: \*Environmental impact, \*Landfills, \*Municipal wastes, \*Public opinion, \*Public participation, \*Waste disposal, Attitudes, Management planning, Noise, Nuisance, Odors.

Host communities often very strongly oppose municipal waste disposal facilities despite the absence of very serious physical impacts. To effectively manage facility impacts and siting process and to reduce host community opposition, waste management engineers and planners must understand the linkage between physical impacts and beliefs and the resulting attitudes in the host community. Physical impacts, community beliefs, and attitudes were assessed at two typical waste facilities. Physical impacts, community beliefs, and attitudes were assessed at two typical waste facilities: a landfill and an incinerator for municipal solid waste. Typical landfill impacts consist of water and air quality effects, odors, noise, and visual impacts, incinerators generate air quality impacts, visual, and noise effects. While residents' general beliefs about facility impacts focus on obvious physical impacts (noise, odor, air emissions), residents' opinions of specific facilities comprise a broader set of physical and nonabysical impacts including prophysical and nonabysical and nonabysical and nonabysical and nonabysical impacts in prophysical and nonabysical and nonabysical impacts in prophysical and nonabysical impacts in a prophysical and n objection technics compiles a footest set of objective data of the sure to obvious nuisance impacts and correlate strongly with residents' attitudes about the facility. Therefore, impact management efforts will be effective if they, first, correctly identify underlying concerns and, then, manage the physical impacts that trigger them. (Author's abstract) W91-11280

### ASSIGNMENT OF THE CLASS OF HYDRAU-LIC-FILL WASTE DUMPS,

V. G. Panteleev.

Hydrotechnical Construction HYCOAR, Vol. 24, No. 6, p 362-369, December 1991. 3 tab. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, pp. 9-13, June, 1990.

Descriptors: \*Hydraulic fill, \*Mine wastes, \*Waste dumps, Classification, Design criteria, Dump failure, Mathematical equations, Soviet Union, Standard, Section 19

Hydraulic-fill dumps throughout the world have been known to fail, resulting in loss of life and disastrous pollution of the environment. Based on disastrous pollution of the environment. Based on recorded failures of tailings dumps in various parts of the world and other data, a multi-parameter system was devised for classification of hydraulic fill dumps. The class of a given hydraulic fill dump can be calculated by a formula that incorporates the following statistics about the dump: length of embankments; volume and mineralization of water settling in the pool; qualifications of specialists; degree of cascade character of construction; and degree of cascade character of construction; and location of buildings and structures in the zone of a possible dam-break wave. The method proposed here makes it possible to classify hydraulic-fill dumps uniformly regardless of which department within the Soviet Union was responsible for their construction. This is necessary because the standards and procedures offered by the various departments differ in the way they classify such structures. Besides standardizing classification, the new they despond the procedure of the processor of the proce method also will make it possible to improve the attitude of design, construction, and operating organization in relation to these structures. (Rochester-PTT) W91-11285

LABORATORY STUDIES OF VIRUS SURVIV-AL DURING AEROBIC AND ANAEROBIC DI-GESTION OF SEWAGE SLUDGE.

Florida Univ., Gainesville. Lab. of Environmental Microbiology.

For primary bibliographic entry see Field 5D.

TRICKLE IRRIGATION OF SUNFLOWER WITH MUNICIPAL WASTEWATER.
Agricultural Research Inst., Nicosia (Cyprus).
For primary bibliographic entry see Field 3F. W91-11435

AGRONOMIC EFFECTS OF LAND APPLICATION OF WATER TREATMENT SLUDGES. Pennsylvania State Univ., University Park. Dept. of Agricultural Engineering. For primary bibliographic entry see Field 4C. W91-11459

RADIOACTIVITY IN WATER TREATMENT WASTES; A USEPA PERSPECTIVE. Environmental Protection Agency, Washington, DC. Office of Drinking Water.
For primary bibliographic entry see Field 5B.
W91-11461.

TREATMENT TECHNOLOGIES FOR ORGAN-OCHLORINE-CONTAINING SLUDGES AND CONCENTRATES FROM EXTERNAL TREAT-MENT OF PULP AND FAPER MENT OF WASTEWATERS.

Swedish Environmental Research Inst., Stock-For primary bibliographic entry see Field 5D. W91-11500

THERMOCATALYTIC AND CHEMICAL TREATMENT OF LIGNIN-ALUMINIUM SLUDGE AND UTILIZATION OF THE RESULTING ADSORBENT-COAGULANT. Leningrad Technological Inst. for the Pulp and Paper Industry (USSR). For primary bibliographic entry see Field 5D. W91-11503

NITROGEN DYNAMICS OF PULP AND PAPER SLUDGE AMENDMENT TO FOREST

Washington Univ., Seattle, Coll. of Forest Resources. C. L. Henry.

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 417-425, 1991. 2 fig, 6 tab, 12 ref.

Descriptors: \*Fate of pollutants, \*Forest soils, \*Land disposal, \*Nitrogen, \*Pulp wastes, \*Sludge utilization, \*Soil amendments, \*Waste utilization, Fertilizers, Forests, Nutrient removal, Plant growth, Primary sludge, Pulp and paper industry, Secondary sludge, Soil chemistry.

The use of pulp and paper sludge as a forest soil amendment was investigated. The fate of nitrogen added from field applications of pulp and paper sludge was determined. Primary sludge was found to immobilize small amounts of N, whereas secondary sludge mineralized over 70% of the N over a 21 month period. A large portion (39-82%) of the mineralized N was not accounted for by uptake, soil storage and nitrate leaching, and was assumed to be gaseous losses. Growth response from pulp and paper sludge amendments was measured. Surface application of primary sludge apparently had a beneficial mulching effect, as growth was 52-131% greater than in control soils. Addition of N to primary sludge resulted in growth 151-223% greater than in controls. Secondary sludge surfaceapplied resulted in excellent growth compared to controls (112-319% greater). (See also W91-11467) (Author's abstract) W91-11510

PRODUCTION OF CHIRONOMID LARVAE IN CULTURING MEDIA OF VARIOUS OR-GANIC WASTES.

Kalyani Univ. (India). Dept. of Zoology. For primary bibliographic entry see Field 8I. W91-11526

HAZARD ASSESSMENT RESEARCH STRATE-GY FOR OCEAN DISPOSAL

### Group 5E—Ultimate Disposal Of Wastes

Environmental Research Lab., Narragansett, RI. J. H. Gentile, V. J. Bierman, J. F. Paul, H. A. Walker, and D. C. Miller. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-134388. Price codes: A03 in paper copy, A01 in microfice. Report No. EPA/600/D-89/231, 1989. IN: Oceanic Processes in Marine Pollution, Volume 3, Robert E. Krieger Publishing Co., Malabar, Florida, 1989. p 199-212, 14 fig. 1 tab, 17 ref.

Descriptors: \*Ocean dumping, \*Waste disposal, \*Risk assessment, \*Water pollution effects, Sludge disposal, Biological studies, Case studies, Long Island Sound, Statistical analysis, Model studies.

The hazard assessment research strategy is a proc ess which provides the necessary data and the predictive and interpretive framework for estimating the probability of harm to the environment. This strategy contains several components, each of which involves acquisition and synthesis of information leading to a regulatory decision. The objective of this strategy is to produce a systematic, scientifically sound basis for estimating the probability of any potential impact of waste contaminants on marine environments, forming the basis for an ultimate disposal decision. Two case studies were used to illustrate how a hazard assessment strategy synthesizes exposure and effects information to provide a causal linkage between mass inputs of contaminants and biological effects. The first study examines sewage sludge disposal at Deepwater Dumpsite-106. This was chosen as an example of how exposure fields for sludge contaminants can be generated with simple probabilis-tic models and how exposure and effects information can be synthesized to predict the relationship between mass inputs of contaminants and biologi-cal effects. For polychlorinated biphenyls, the maximum predicted environmental concentrations outside the dumpsite for the low-mixing and highousside the uninpact for the row-maxing and ingi-mixing cases were 0.06 and 0.019 ng/L, respective-ly, at least two orders of magnitude lower than the water quality criterion value of 5 ng/L, which in turn represents a no-effect concentration. Thus, the turn represents a no-enect concentration. Thus, the probability of hazard is not particularly high, although the hazard to a percentage of organisms affected cannot be accurately determined. The second study, which examines the disposal of dredged material in a shallow coastal site in central Long Island Sound, is a field verification program designed to test methodologies required for the acquisition of exposure and effects information. Both the laboratory and field data are synthesized to evaluate the accuracy and confidence of predic-tions of the individual methods, the tiered hierarchal concept, and the final prediction. (Lantz-PTT) W91-11551

### 5F. Water Treatment and **Quality Alteration**

SPECIAL REPORT: WATER SUPPLY AND SANITATION.

Bulletin of the Pan American Health Organization BPAHA3, Vol. 25, No. 1, p 87-96, 1991.

Descriptors: \*Developing countries, \*Drinking water, \*Sanitation, \*Water supply, \*Water treatment, Aquaculture, Cost analysis, Health effects, Irrigation, Latin America, Monitoring, Municipal wastewater, Surveys, Wastewater disposal, Wastewater treatment, Water quality control,

The United Nations Water Conference, held at Mar del Plata, Argentine, in 1977, recommended that 1981-1990 be designated the International Drinking Water Supply and Sanitation Decade. The purpose of the Decade was to provide a safe and adequate supply of drinking water as well as and adequate supply of drinking water as well as basic sanitary facilities to all people by 1990. During that Decade, the percentage of the urban population served by sanitary excreta disposal sys-tems increased from 78-80%; however, the actual number of people without such service also in-creased, by 7.6 million. Most countries have water quality surveillance and control programs in urban areas, and many have programs in rural areas. Surveillance programs are often, unfortunately, in-effective or only partially implemented. Surveys suggest that 75% or more of the water supply systems either did not provide effective disinfec-tion or had operational problems that interfered with it. In peripheral urban areas, the quality standards set by the countries were often not met and water use was generally inefficient, with losses as high as 60% of the water produced. 1988 data as high as own of the water produced. 1986 data indicate that wastewater from only 5-10% of urban households connected to water and sewerage receives treatment. Municipal wastewater can become an economically valuable resource when it become an economically valuation resource when it is reused for irrigation and aquaculture. However, uncontrolled use of untreated wastewater for irrigation poses health hazards. Investments made during the Decade were substantially less than the totals proposed for meeting established goals, due to the impact of external debt and inflation. Another Regional Conference on Water Supply and Sanitation, was held in September, 1990 in San Juan, Puerto Rico. A hundred participants representing 23 countries and external support agencies met to examine achievements. Strategies of international and bilateral and support for the formulation and execution of national programs were examined. (Mertz-PTT) W91-10482

#### LESSONS LEARNED FROM A THIRD WORLD WATER AND SANITATION PROJECT.

T. Jenkins-McLean. Journal of Environmental Health JEVHAH, p 34-38, Spring 1991. 2 fig, 4 ref.

Descriptors: \*Belize, \*Community development, \*Developing countries, \*Public health, \*Sanita-tion, \*Water supply, Education, Municipal wastewater, Public participation, Water quality, Water supply development.

In 1985, the United States Agency for International Development signed a contract with the Pragma Corporation to provided technical assistance to the Government of Belize. The goal of the water and sanitation component of the project was to ensure an adequate and safe water supply to 90% of the rural population in three districts; to provide larural population in three astracts; to provide in-trines or sanitation technologies to ensure 50% coverage of the districts; and to establish a rural water supply laboratory facility to monitor water quality. Community participation was the key to successful implementation of the project. Greater community participation was achieved when limited local resources were complemented by external resources. Educational campaigns concerning community development increased participation. For success, the village should express a genuine desire for the project and agree with the goals set cooperatively. Decentralization of government bureaucracy made the programs more accessible at the community level. Throughout the project, community ownership of the water and sanitation systems must be stressed to encourage improved maintenance of the systems. Advantages and disadmaintenance of the systems. Advantages and disad-vantages of the different types of water and sanita-tion systems must be thoroughly explained to enable community members to understand the ap-propriate technology. The job of the project staff is to make realistic assessments for available re-sources and labor contributions. If women were fully involved in decisions to improve household sanitation, they would be better able to educate their families in practices that improve health and hygiene. In communities with longstanding tradi-tions of cooperative work endeavors, mobilization of community members required less effort from the project staff and village leaders. (Mertz-PTT)

### HEALTH-RELATED WATER MICROBIOLO-

For 1990. Proceedings of an international symposium organized by the International Association on Water Pollution Research and Control Specialist Group on Health-Related Water Microbiology held in Tuebingen, Germany, 1-6 April 1990. Water Science and Technology WSTED4, Vol. 24, No. 2, 1991. 433p. Edited by W. O. K. Grabow, R. Morris, and K. Botzenhart.

Descriptors: \*Conferences, \*Drinking water, \*Epidemiology, \*Microbiological studies, \*Public health, \*Risk assessment, \*Water pollution, \*Water quality monitoring, \*Water supply, Analytical methods, Aquatic bacteria, Bacteriophage, Biofilms, Disinfection, Fish, Gene probes, Groundwater pollution, Human diseases, Legionella, Parasites, Shellfish, Viruses, Wastewater, Water quality standards.

These proceedings present peer-review-selected papers on health aspects of microbiology. Epidemi-ological studies and research on the quality of water supplies have revealed that drinking water may constitute meaningful to extensive health risks may constitute meaningful to extensive health risks, but also in highly developed and industrialized countries. Population growth, which increases the demand for potable water and at the same time generates more wastes which may pollute available water resources, poses special challenges to all involved in the water industry. Progress in the development of practical and reliable methods for the assessment and control of the quality of water and wastes was a special feature of this symposium—a much better understanding has emerged of the present and future value of advanced gene probe and immunological techniques for the detection of viruses, bacteria, and protozoa. The 86 articles in this volume are grouped under the foltion of viruses, bacteria, and protozoa. The 86 articles in this volume are grouped under the following general headings: (1) Disease Outbreaks and Risk Assessment; (2) Microbiological Standards and Quality Control; (3) Bacteria in Drinking Water; (4) Bacteria in Fresh and Estuarine Waters; (5) Bacteria in Marine Waters; (6) Legionella and Biofilms; (7) Parasites; (8) Viruses in Water; (9) Virus Methods; (10) Bacteriophages; (11) Gene Probes; (12) Groundwaters and Bank Filtration; (13) Disiripaction; (14) Wastewaters; and (15) Eish (13) Disinfection; (14) Wastewaters; and (15) Fish and Shellfish. (See W91-10613 thru W91-10698) (Shidler-PTT)

MICROBIOLOGICAL METHODS FOR SAFETY TESTING OF DRINKING WATER DIRECTLY RECLAIMED FROM WASTEWATER. Pretoria Univ. (South Africa). Dept. of Medical

For primary bibliographic entry see Field 5A. W91-10613

HEALTH RISK ASSESSMENT OF WATER CONTAMINANTS USING BASELINE DATA OF CANCER INCIDENCE IN DIFFERENT WATER SUPPLY AREAS.
Universitaet fuer Bodenkultur, Vienna (Austria).

Inst. fuer Wasservorsorge.

R. Walter, K. Stania, T. Hantzsche, R. Ittlinger, and W. Macht.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 5-12, 1991. 5 fig, 12 ref.

Descriptors: \*Cancer, \*Drinking water, \*Epidemiology, \*Human diseases, \*Risk assessment, \*River Elbe, \*Water pollution effects, Groundwater, Kidneys, Liver, Statistical analysis.

retrospective epidemiological study of cancer incidence was conducted in 3 communities along the River Elbe. Using the National Cancer Regis-ter, about 10,000 cases of different types of cancer suspected to be at least partially caused by polluted water were checked for the 17-year period 1968-1984. Study areas were those where the Elbe is the source of drinking water, while in control areas water is obtained from groundwater or reservoirs. water is obtained from groundwater or reservoirs. In Pirna, cancer of the stomach, colon, rectum, liver, pancreas, and kidney occurred more frequently in the study area. Differences are statistically significant for cancer of the stomach in both sexes, of liver in men, and of pancreas in women. In Dresden, a higher incidence was observed in the study area for center of stomach color rectum. study area for cancer of stomach, colon, rectum, gall bladder, pancreas, urinary bladder, and kidney. Statistical significance was evident for cancer of colon, rectum, and gall bladder in men and urinary bladder in both sexes. In Riesa, the incidence was higher in the study area for cancer of the rectum, liver, gall bladder, pancreas, urinary bladder, and kidney. Statistical significance could

### Water Treatment and Quality Alteration—Group 5F

be demonstrated for cancer of rectum and liver in men and for pancreas, urinary bladder, and kidney in women. The cancer risk related to the risk for all East Germany was as high as 145% for liver cancer in Piran (men), 160% for liver cancer and 170% for kidney cancer in Riesa, and 170% for kidney cancer in Riesa. It is concluded that a water-pollution-associated health risk cannot be rejected. (Author's abstract) W91-10614

WATERBORNE DISEASE OUTBREAK. Stockholm National Bacteriological For primary bibliographic entry see Field 5C. W91-10615

CAUSES OF WATERBORNE OUTBREAKS IN THE UNITED STATES. Environmental Protection Agency, Cincinnati, For primary bibliographic entry see Field 5B. W91-10616

THAMES WATER'S EXPERIENCES WITH CRYPTOSPORIDIUM. Thames Water Authority, Reading (England). For primary bibliographic entry see Field 5C.

PROSPECTIVE EPIDEMIOLOGICAL STUDY OF DRINKING WATER RELATED GASTROIN-TESTINAL ILLNESSES. Institut Armand-Frappier, Laval (Quebec). For primary bibliographic entry see Field 5B. W91-10618

USE OF RISK ASSESSMENT FOR DEVELOP-MENT OF MICROBIAL STANDARDS. University of South Florida, Tampa. Dept. of Environmental and Occupational Health. For primary bibliographic entry see Field 5G. W91-10619

PUBLIC HEALTH CRITERIA FOR THE AQUATIC ENVIRONMENT: RECENT WHO GUIDELINES AND THEIR APPLICATION. World Health Organization, Geneva (Switzerland). Div. of Environmental Health. For primary bibliographic entry see Field 5G. W91-10620

NEED FOR NEW MICROBIOLOGICAL WATER QUALITY CRITERIA.
National Research Centre, Cairo (Egypt). Water n Control Lab. H. T. El-Zanfalv. Water Science and Technology WSTED4, Vol. 24, No. 2, p 43-48, 1991. 4 tab, 16 ref.

Descriptors: \*Bacteria, \*Drinking water, \*Egypt, \*Public health, \*Water quality standards, \*Water treatment, Antibiotics, Bacterial analysis, Cairo, Chlorination, Culturing techniques, Groundwater quality, Surface water.

The occurrence of antibiotic-resistant bacteria was assessed in treated drinking water and in untreated groundwater in Cairo. Resistant bacteria were found among standard plate count populations of found among standard plate count populations of chlorinated drinking water from two districts. Most strains appeared to be ampicillin-resistant (89%), followed by sulfaguanidine (78%) and streptomycin (57%). Most tested strains (62.4% to 98%) were multiple antibiotic resistant (MAR). Identification of MAR strains revealed that Gram-positive rods were dominant, followed by Gram-negative fermentative rods. Gram-positive conpositive rods were dominant, followed by Gram-negative fermentative rods, Gram-positive cocci, and Gram-negative nonfermentative rods. A total of 101 strains isolated from underground water pumped from three waterworks in Cairo were classified and tested for their resistance to four commonly used antibiotics and one chemotheracommonly used antiolous and one themotraction peutic agent (sulfanilamide pyrimidine). Results showed that 77, 64, and 32 isolates have resistance to penicillin, sulfanilamide pyrimidine, and tetracycline, respectively. Only 18 and 8 isolates were resistant to chloramphenicol and neomycin, re-spectively. It was also found that 19 isolates be-longing to 6 genera or groups were sensitive to-wards all of the tested compounds. It is concluded that data on MAR bacteria should be considered in water multir, deliberations and the regulation of water quality deliberations and the regulation of effluent quality. (See also W91-10612) (Author's abstract) W91-10621

EVALUATION OF FECAL ENTEROCOCCI ISOLATION MEDIA TO INDICATE FECAL POLLUTION IN CHLORINATED WATER, Rand Water Board, Johannesburg (South Africa). C. M. E. de Wet, M. Grundlingh, B. Louw, and D.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 77-80, 1991. 1 tab, 11 ref.

Descriptors: \*Bioindicators, \*Chlorination, \*Culture media, \*Drinking water, \*Fecal bacteria, \*Water analysis, \*Water quality monitoring, \*Water tratment, Agars, Bacteria, Isolation, Performance evaluation, Water quality control.

The selectivity of mEnterococcus and KF strepto-The selectivity of menteroceus and Ar strepto-coccus agar or the isolation of fecal enterococci from chlorinated water were compared. Typical as well as atypical colonies were picked off and puri-fied for identification. Neither mEnterococcus nor streptococcus agar proved to be the ideal ation medium, as some 30% of the colonies isolation medium, as some 30% of the colonies with a typical appearance were catalase and benzidine positive, Gram-positive cocci. Catalase and benzidine negative, Gram-positive cocci isolated on KF streptococcus agar were identified as: Enterococcus faecalis (6%), E. faecium (7%), E. galliarum (2%), E. casselfiavus or E. mundtii (17%), E. avium (0.4%), E. durans (0.2%). Twenty-four percent could not be identified. Similar isolates on mEnterococcus agar were identified as: E. faecalis (14%), E. faecium (12%), E. galliarum (2%), E. percent could not be identified. Similar solates on mEnterococcus agar were identified as: E. faccalis (11%), E. faccium (12%), E. gallinarum (2%), E. casseliflavus or E. mundtii (36%), E. avium (1%) plus 9% that could not be identified. Results indiplus 9% that could not be identified. Results indicate that the use of either mEnterococcus or KF streptococcus agar for the indication of fecal pollution in chlorinated water has limited value. Isolates have to be identified to species level to confirm the presence of fecal enterococci. This practice is time-consuming and impractical for water quality control purposes. (See also W91-10612) (Author's abstract) stract) W91-10626

COLIFORM BACTERIA IN DRINKING WATER FROM SOUTH BAVARIA: IDENTIFICATION BY THE API 20E-SYSTEM AND RE-SISTANCE PATTERNS.

Landesuntersuchungsamt fuer das Gesundheitswe-sen Suedbayern, Munich (Germany, F.R.). P. R. G. Schindler, and H. Metz. Water Science and Technology WSTED4, Vol. 24, No. 2, p 81-84, 1991. 4 tab, 6 ref.

Descriptors: \*Analytical methods, \*Bacterial analysis, \*Coliforms, \*Drinking water, \*Germany, \*Water analysis, \*Water treatment, Bavaria, Citrobacter, Klebsiella, Seasonal variation, Serratia, Water quality standards.

A total of 256 coliform strains (132 from central, 124 from decentralized water supplies in Bavaria) as defined by the German drinking water regulation were characterized by the API 20E-system and by their susceptibility to 15 antimicrobial agents. Altogether, 22 different species from 10 genera could be differentiated, whereas 14 strains were unidentifiable by the system. The frequency distribution of the strains isolated from central water supplies yielded 48.5% for Citrobacter freundii, 17.4% for Klebsiella pneumoniae, 6.8% for Buttiauxella agrestis, and 6.1% for C. diversus. In decentralized water supplies. C. freundii was found in 33.9%, K. pneumoniae in 14.5%, Serration fonticola in 8.9%, and K. oxytoca in 6.5%. About one third (73 strains) were fully susceptible to all antibiotics tested. However, 42 strains displayed complete or moderate resistance against three or total of 256 coliform strains (132 from central, complete or moderate resistance against three or more agents. Within this group of multiresistant strains, a seasonal variation was evident. The pro-portion of multiresistant isolates was relatively

high in the first half of the year (21.4% from January to March and 29.4% from April to June) and relatively low in the second half of the year (7.9% from July to September and 11.3% from October to December). This distribution may indicate a conservation of R-factor-bearing bacteria in the environment. (See also W91-10612) (Author's abstract) W91-10627

EFFECT OF HEAT SHOCK ON RECOVERY OF ESCHERICHIA COLI FROM DRINKING WATER.

RObens Inst. of Industrial and Environmental Health and Safety, Guildford (England). C. Berry, B. J. Lloyd, and J. S. Colbourne. Water Science and Technology WSTED4, Vol. 24, No. 2, p 85-88, 1991. 1 fig, 11 ref.

Descriptors: \*Bacterial analysis, \*Culturing techniques, \*Drinking water, \*Escherichia coli, \*Temperature effects, \*Water analysis, \*Water treatment, Agars, Aquatic environment, Bacterial physiology, Culture media, Microscopy, Survival.

Recent studies have suggested that bacteria in the aquatic environment may enter a viable 'nonculturable phase' in response to stress. It has been found that mild heat shock causes viable nonculturable Legionella pneumophila to grow on laboratory media. The survival and culturability of Escherimedia. The survival and culturability of Escherichia coli in sterile drinking water was investigated using environmental, rather than clinical, isolates. As expected, the count by culture on nutrient agar declined with time while the microscopy count remained approximately constant. Under laboratory conditions, the E. coli isolates survived up to three months or more. After three months, a portion of each suspension was heat shocked at 35 C for 20 minutes and then assayed by culture and microscopy immediately. An average increase of three log cycles was noted in the count by culture. There was no corresponding increase in the count by microscopy. Thus, E. coli appears to exhibit viable nonculturable behavior; heat shock causes nonculturable bacteria to grow on artificial media. viable nonculturable behavior; heat shock causes nonculturable bacteria to grow on artificial media. Therefore, it cannot be assumed that bacteria like E. coli will necessarily die off in a low-nutrient environment, even after several weeks. It also cannot be assumed that simple culture techniques are adequate when assessing fecal pollution, and possible health risks, in such water. Mild heat treatment prior to culture might increase the likelihood of obtaining positive results. (See also W91-10612) (Doria-PTT)

BIODEGRADABLE DISSOLVED ORGANIC CARBON (BDOC) CONTENT OF DRINKING WATER AND POTENTIAL REGROWTH OF BACTERIA.

Centre de Recherche de Maisons-Laffitte (France). Centre de Nesterierie de Wassolis-Lainte (Plante). J. C. Joret, Y. Levi, and C. Volk. Water Science and Technology WSTED4, Vol. 24, No. 2, p 95-101, 1991. 3 fig, 1 tab, 13 ref.

Descriptors: \*Bacterial growth, \*Bioassay, \*Biodegradation, \*Dissolved organic carbon, \*Drinking water, \*Organic carbon, \*Water analysis, \*Water treatment, Aeration, Bacteria, Chlorination, Disinfection, Incubation, Nutrients, Organic com-pounds, Sand, Wastewater facilities, Water distri-bution.

Total organic carbon (TOC) is not a good predictor of bacterial regrowth in distribution systems because the ratio of organic nutrients to TOC is not constant. Therefore, methods are needed for rapidly estimating the quantities of organic nutri-ents in finished water samples. Attempts have been made to assess the total amount of biodegradable made to assess the total amount of biodegradable organic carbon (BDOC) in drinking water. In this investigation, BDOC in water was evaluated by the reduction of dissolved organic carbon (DOC) during an ultimate biodegradation process in the presence of natural and fixed bacteria in aerated conditions. The inoculum consisted of 100 g of prewashed biological active sand (BAS) from a wastewater treatment plant without any prechlorination. BAS was prewashed with distilled water

### Group 5F—Water Treatment and Quality Alteration

until no detectable DOC is released, then added to 300 ml of the water sample. Using such an abundant fixed flora allows both a rapid response (3-5 days) and no organic contamination of the sample. DOC values were recorded daily until a minimum was reached. The BDOC of the water sample was advanted by their or the different particular or the sample was reached. The BDOC of the water sample was reached that the sample was a secondated to the sample was a seconda was reached. The BJDC of the water sample was calculated by taking the difference between initial and minimum DOC reached after a few days' incubation period of the aerated sample incubated at 20 C in contact with BAS. The bioassay was found to be accurate, precise, reproducible, and sufficiently sensitive even for distributed water. (See also W91-10612) (Doria-PTT)

ELIMINATION OF COLIPHAGES, CLOSTRID-IUM PERFRINGENS AND HUMAN ENTERIC VIRUSES DURING DRINKING WATER TREATMENT: RESULTS OF LARGE VOLUME SAMPLINGS.

Institut Armand-Frappier, Laval (Quebec).

P. Payment.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 213-215, 1991. 2 tab, 4 ref.

Descriptors: \*Bacteriophage, \*Bioindicators, \*Clostridium, \*Viruses, \*Water treatment, Agars, Assay, Chlorination, Escherichia coli, Filters, Filtration, Immunoassay, Membrane processes, Ozonation, Pollutant identification, Sample preparation, Sampling, Water analysis.

The elimination of human enteric viruses, coliphages, and Clostridium perfringens by drinking water treatment was studied using a single filtration method of 100 L (raw and settled water) or 1,000 L (filtered tap water). The VIRADEL method was used to concentrate these organisms method was used to concentrate these organisms on electronegative filters. Concentrates were assayed for human enteric viruses on MA-104 cells using two blind passages and an HISG-immunoperoxidase method. Coliphages were assayed by plaque assay using a nalidixic acid resistant ATCC 13706 E. coli host strain by the double layer agar method. Clostridium perfringens were enumerated by membrane filtration on m-CP agar. The water filtration plant studied uses full conventional treatment, including ozonation and postchlorination. Results suggest that, using similar volumes of waters for the detection of these indicators, colihages and C. perfringens are slightly more resistphages and C. perfringens are slightly more resist-ant than cultivable human enteric viruses and that they could therefore serve as rapid indicators for the elimination of human enteric viruses in treated waters. Large volume samplings are necessary to evaluate the virological quality drinking water correctly even when using potential indicators such as coliphages and clostridia. The methods used in this coliphages and clostridia. The methods used in this study still rely on sampling large volumes of water, although results were obtained much more rapidly: 6-25 h for coliphages and 48 h for clostridia, compared to several days or weeks for most virological analyses. (See also W91-10612) (Doria-PTT) W91-10654

EFFECTIVITY OF CHLORINE DIOXIDE TO CONTROL AEROMONAS IN DRINKING WATER DISTRIBUTION SYSTEMS. Rijksinstitut voor de Volksgezondheid, Bilthoven (Netherlands). Lab. for Water and Food Microbi-

G. J. Medema, E. Wondergem, A. M. van Dijk-Looyaard, and A. H. Havelaar. Water Science and Technology WSTED4, Vol. 24, No. 2, p 325-326, 1991.

Descriptors: \*Aeromonas, \*Bacteria, \*Chlorina-tion, \*Chlorine dioxide, \*Disinfection, \*Drinking water, \*Water treatment, Dissolved organic carbon, Mortality, Residual chlorine, Water con-

Chlorine dioxide was evaluated as a disinfecting agent to control Aeromonas in drinking water distribution systems. It was found that the ClO2 demand of drinking water is primarily a function of the dissolved organic carbon (DOC) content and the initial ClO2 concentration. In most drinking waters, a ClO2 dose of 0.2 mg/L is completely consumed within 10 min. Aeromonas is relatively sensitive to ClO2 compared to other Gram-negative bacteria. There is no significant difference in the sensitivity to ClO2 between laboratory cultures and natural populations of Aeromonas. Therefore, the results of the model experiments can be extrapolated directly to disinfection practice. Aeromonas is as sensitive to ClO2 as to free available chlorine at nH 80. Chloring dioxide can be an effective. at pH 8.0. Chlorine dioxide can be an effective agent for post-disinfection provided the ClO2 demand of the receiving water is low. Significant die-off of Aeromonas occurs only in the presence of a residual ClO2 concentration; reaction products of a residual LO2 concentration; reaction products such as chlorite or chlorate have no effect on growth of Aeromonas in the range of the concentrations present in drinking water (1 mg/L). The use of ClO2 for protection against growth of Aeromonas in distribution networks at a dose of 0.2 mg/ monas in distribution networks at a dose of 0.2 mg/L is limited to waters that are treated with activated carbon and/or have a low DOC content. For effective protection, a ClO2 residual should be maintained throughout the network. In most water types, this can be established only be addition of higher ClO2 doses (0.5-1 mg/L). (See also W91-10612) (Doria-PTT)

CHLORINE RESISTANCE OF MOTILE AERO-

MONAS SPP.
Vandkvalitetsinstitutet, Hoersholm (Denmark).
S. Knochel.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 327-330, 1991. I fig, 1 tab, 7 ref.

Descriptors: \*Aeromonas, \*Bacteria, \*Chlorina-tion, \*Chlorine, \*Disinfection, \*Pathogenic bacte-ria, \*Water treatment, Acinetobacter, Assay, Coli-forms, Culturing techniques, Drinking water, Es-cherichia coli, Hydrogen ion concentration, Kleb-siella, Mortality, Pseudomonas, Resistance, Tem-

The presence of high numbers of Aeromonas spp. is undesirable in the water supply, as they are potentially pathogenic and may cause food spoilage. Aeromonas spp. have been found in chlorinated drinking water where coliform counts were low. A study was conducted to examine the level of and variation in chlorine resistance of Aeromonas present the supplementation of monas spp. Two methods were employed. Screening of relative chlorine resistance was done on 46 clinical and 41 environmental isolates of Aeroclinical and 41 environmental isolates of Aeromonas spp. at 30 C using a disk assay with four concentrations of hypochlorite, and results were compared with those for Escherichia coli, Pseudomonas fluorescens, Klebsiella, P. aeruginosa, and Acinetobacter. Resistance varied greatly between Aeromonas isolates, but they were in general more susceptible than the other bacteria tested. Inactivation studies were conducted following the survival of selected isolates in solutions of manchloramine of selected isolates in solutions of monochloramine (0, 0.5, 1.0, and 2.0 mg/L) over a period of 180 minutes at pH 7.0 and 10 C. The most resistant strain in the disk assay was also the most resistant strain in the disk assay was also the most resistant in the inactivation study. No significant variation was observed with relation to Aeromonas species, or with relation to the origin of the isolates. However, it should be noted that only a few of the isolates came from chlorine-stressed environments with selective pressures. (See also W91-10612) (Author's abstract) W91-10678

COMPARATIVE INACTIVATION OF HEPATITIS A VIRUS AND OTHER ENTEROVIRUSES IN WATER BY IODINE.

NWATER BY RODINE.
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
M. D. Sobsey, C. E. Oldham, and D. E. McCall.
Water Science and Technology WSTED4, Vol.
24, No. 2, p 331-337, 1991. 3 fig, 3 tab, 20 ref.

\*Disinfection. Descriptors: \*Enteroviruses. Hodine, \*Viruses, \*Water treatment, Bentonite, Buffering, Fulvic acids, Humic acids, Hydrogen ion concentration, Phosphates, Temperature, Turbidity.

Iodine is used as a disinfectant of small and field water supplies, but little is known of its ability to inactivate important waterborne viruses such as hepatitis A virus (HAV). The inactivation of purified, aggregated HAV, poliovirus type 1, and echovirus types 1 and 8 were determined in the laboratory using 1, 8, and 16 mg/L doses of iodine in both phosphate buffered, iodine-demand-free (clean) water and the same water containing 10 mg/L of a 1:1 mixture of humic and fulvic acids and 5 NTU of bentonite clay turbidity (dirty and 5 NTU of bentonite clay turbidity (dirty water). Virus inactivation studies in clean water were done at pH 4.5, 7.0, and 9.5 and at 5 and 25 C, and in dirty water at the same pH levels but at 5 C only. Iodine in doses of 8 and 16 mg/L in clean water produced 99.99% or 4 log(base 10) inactivation of HAV by 60 min or less. Four log(10) inactivation of polio 1 and echo 1 was not achieved in 60 min by 8 mg/L iodine at 5 C and pH 7.0 and inactivation of polio 1 and echo 1 was not achieved in 60 min by 8 mg/L loidine at 5 C and pH 7.0 and 4.5 or by 16 mg/L loidine at 5 C and pH 4.5. HAV was inactivated more efficiently by iodine than were the other two test viruses, and the overall order of virus inactivation was: HAV > echo 1 > polio 1. Virus inactivation was generally more effective at higher pH, in cleaner water, at higher temperature, and at higher iodine dose. (See also W91-10612) (Author's abstract) W91-10679

UV DISINFECTION: SHORT TERM INACTI-VATION AND REVIVAL.

Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Due-bendorf (Switzerland).

K. Mechsner, T. Fleischmann, C. A. Mason, and G. Hamer.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 339-342, 1991. 5 fig, 2 ref.

Descriptors: \*Bacterial growth, \*Disinfection, \*Ultraviolet radiation, \*Water treatment, Bacteria, Escherichia coli, Groundwater, Microbiological studies, Organic matter, Surface water, Wastewater.

The regrowth potential of bacteria sublethally injured by ultraviolet (UV) treatment was investigated using a laboratory culture of Escherichia coil and natural mixed populations isolated from wastewater and stream water. Regrowth subsequent to 4 min UV radiation of E. coli suspensions ccurred under both light and dark storage conditions. Similar responses were noted with a natural stream sample and with a suspension of 1% wastewater in groundwater. Following continuous UV treatment, there appeared to be a direct relationship between the intensity of radiation and the tionship between the intensity of radiation and the potential for regrowth and repair. Moreover, the more intense the level of irradiation, the greater the extent of lysis of refractory substrates and of susceptible bacteria, resulting in the release of organic material available for reassimilation by bacteria able to regrow in the system. Continuous irra-diation of the mixed bacterial culture in river water diation of the mixed bacterial culture in river water resulted in 100% suppression of the bacteria after 1 hour. However, continued irradiation resulted in the appearance of UV-resistant bacteria in the supension, which were apparently able to grow on the lysis products of other bacteria from the suspension. Therefore, after 3 days the total cell counts were comparable to those found following 4 min of irradiation. It is concluded that regrowth is enhanced by increasing UV intensity in waters containing residual organic matter, and that the treatment of such waters using UV irradiation should be reevaluated. (See also W91-10612) (Doria-PTT) W91-10680 W91-10680

DISINFECTION CAPABILITY IN WATER FOR SWIMMING AND BATHING POOLS: A SIMPLE METHOD FOR THEIR EVALUATION IN PRACTICE.

Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene. K. M. Seidel, J. M. Lopez Pila, and A. Grohmann. Water Science and Technology WSTED4, Vol. 24, No. 2, p 359-362, 1991. 1 fig, 10 ref.

Descriptors: \*Disinfection, \*Public health, \*Recreation, \*Swimming, \*Water quality monitoring, \*Water teatment, Bacteria, Comparison studies, Escherichia coli, Germany, Human diseases, Laboratory equipment, Legionella, Microorganisms, Pathogens, Fseudomonas, Regulations.

### Water Treatment and Quality Alteration—Group 5F

Prevention of disease transmission in swimming and bathing pools requires maintenance of adequate disinfection capability in the water. Therefore, German regulations require that any procedure for the treatment and disinfection of such water must guarantee a minimum degree of inactivation of human pathogens. A simple method was developed for evaluating the disinfection capability of pool water, expressed as the inactivation rate of selected microorganisms (Pseudomonas aeruginosa, Escherichia coli, and Legionella pneumophila). The test can be carried out onsite in the pool area using simple, standard equipment normally present in microbiological laboratories, and may be used for the evaluation of standard disinfectants as well as those developed in the future. Results achieved with this test show good agreement with those obtained using a sophisticated stopped-flow apparatus developed exclusively for the evaluation of disinfection capability. It is proposed that the reduction of the concentration of P. aeruginosa (starting with a concentration of approximately 1 million cfu/ml) within 30 seconds is to be called 'disinfection capability,' equivalent to the concentration of the indicator bacteria expressed as its decadic logarithm at time zero minus the concentration of the bacteria expressed as its decadic logarithm at time zero minus the concentration of the bacteria expressed as its decadic logarithm at time zero minus the concentration of the bacteria expressed as its decadic logarithm at time 20. Only those pool water treatments with a disinfection capability under maximal operating conditions (high density of users) of 4 or higher are considered to have achieved a safe hygienic condition. (See also W91-10612) (Doria-PTT)

FISCAL YEAR 1988 SUPPORTED LIQUID MEMBRANE DEVELOPMENT REPORT. Westinghouse Hanford Co., Richland, WA. For primary bibliographic entry see Field 5G. W91\_10727.

REMOVAL OF HUMIC SUBSTANCES AND ALGAE BY DISSOLVED AIR FLOTATION. Massachusetts Univ., Amherst. Dept. of Civil Engineering.

Massachusetts Univ., Amnersa. Dept. of Civil Europineering.

J. K. Edzwald, and J. P. Malley.

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-214407.

Price codes: A10 in paper copy, A01 in microfiche.

EPA Report 600/2-89/032, 1989. 183p, 64 fig. 33 tab, 54 ref, 3 append. EPA Agreement CR812639.

Descriptors: \*Air flotation, \*Algae, \*Dissolved air flotation, \*Humic substances, \*Water treatment, Alum, Flocculation, Halides, Polyaluminum chloride, Turbidity.

Dissolved air flotation (DAF) is used in place of conventional gravity settling as a means to separate low density floc particles from water. A comparison was made between DAF and conventional water treatment of coagulation-flocculation followed by gravity settling (CGS) for removals of particles, color, dissolved organic carbon (DOC), trihalomethane (THM) precursors, and total organic halide (TOX) precursors. In addition, the effects of raw water quality, water temperature, chemical variables, flocculation period prior to DAF, and DAF design and operating variables on DAF performance were examined along with an evaluation of alum and polyaluminum chloride (PACI) as pretreatment coagulants for DAF. Results of the DAF experiments, using both synthetic and natural waters, showed that good DAF treatment requires good coagulation; flotation without a prior flocculation period is effective. For waters containing humic substances, there was no significant difference in the removal of UV, true color, dissolved organic carbon, and dissolved organic halide precursors (THM and TOX) between DAF and conventional treatment. However, DAF produced significantly lower turbidities than conventional treatment for all raw water systems, particularly at colder water temperatures. For waters containing algae, DAF produced much greater reductions in algal cell concentrations than conventional treatment. (Author's abstract)

DRINKING WATER CRITERIA DOCUMENT ON XYLENE.

Environmental Protection Agency, Cincinnati, OH. Environmental Criteria and Assessment Office.
For primary bibliographic entry see Field 5C.

COMPUTER MODELING OF SCALE FORMA-TION DURING TREATMENT OF GROUND WATER IN AIR STRIPPERS. Claused OH

Case Western Reserve Univ., Cleveland, OH. Dept. of Geological Sciences. For primary bibliographic entry see Field 5G. W91-10798

BACTERIOPHAGES AS MODEL VIRUSES IN WATER QUALITY CONTROL.
For primary bibliographic entry see Field 5G. W91-10883

DEVELOPMENT OF AN ENZYME-LINKED IMMUNOSORBENT ASSAY FOR GEOSMIN. Southern Regional Research Lab., New Orleans,

LA. S. Y. Chung, J. R. Vercellotti, P. B. Johnsen, and P. H. Klesius. Journal of Agricultural and Food Chemistry JAFCAU, Vol. 39, No. 4, p 764-769, April 1991. 6

fig, 2 tab, 27 ref.

Descriptors: \*Drinking water, \*Enzymes, \*Geosmin, \*Immunoassay, \*Organoleptic properties, \*Water analysis, Analytical methods, Antibodic Cyanophyta, Detection limits, Polyclonal anti-

The feasibility of using polyclonal antibodies raised against a bovine serum albumin (BSA)-argosmin C conjugate to develop an enzyme-linked immunosorbent assay (ELISA) for geosmin was investigated. A direct competitive ELISA for geosmin (a musty/earthy off-flavor compound found in drinking water produced as a metabolite by blue-green algae) was developed. Antibodies were produced in goats injected with a BSA-argosmin C (a dehydration product of geosmin) conjugate. The sensitivity and specificity of the antibody were respectively determined in a microtiter plate coated with the purified antibody which was subsequently detected with an alkaline phosphatase-argosmin C conjugate. The antibody had the most cross-reactivity with an argosmin C related compound, namely, 4,4a,5,6,7,8-hexahydro-4s-methyl-2(3H)-naphthalenone. It cross-reacted equally with geosmin, 2-ketogeosmin, and 2-decalone but had limited recognition for norbornane, indicating that the bidding of the antibody was restricted mainly to the bicyclic structure (A and B rings) of geosmin. Because it had some cross-reactivity with 2-methylisoborneo(MIB), it was assumed that the methyl group in geosmin might also play a role in antibody recognition. In addition, the presence of two OH groups on the A and B rings of 1,5-decalindiol also had an effect on the antibody binding. The assay had a sensitivity of 1 microgram/mL. (Author's abstract)

INCIDENCE OF LEGIONELLA IN THE URBAN ENVIRONMENT IN AUSTRALIA. University of Technology-Sydney, Broadway. Div. of Biological Sciences. For primary bibliographic entry see Field 5B. W91-10929

ANALYSIS OF HALOGENATED ACETIC ACIDS IN DUTCH DRINKING WATER. Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). R. J. B. Peters, C. Erkelens, E. W. B. de Leer, and L. de Galen. Water Research WATRAG, Vol. 25, No. 4, p 473-477, April 1991. 3 fig, 2 tab, 14 ref.

Descriptors: \*Acetic acid, \*Acids, \*Drinking water, \*Halogenated organic compounds, \*The Netherlands, \*Water analysis, Analytical methods, Chlorination, Disinfection, Groundwater, Surface water, Water quality control.

Halo-acetic acids are produced during chlorine disinfection of drinking water. Besides the well known dichloro-, and trichloroacetic acid, brominated and mixed chloro/bromo acetic acids are also produced. A method was developed to determine all halo-acetic acids. This method was applied for the analysis of 20 drinking waters prepared from different source waters. Halo-acetic acids were found in all drinking waters prepared from surface water while they could not be detected in drinking waters prepared from groundwater. The acid concentrations were in the range of 0-14.7 microgram/L and dibromoacetic acid was found to be the most prominent halo-acetic acid in chlorinated waters. Brominated acetic acids accounted for 65% of the total acid concentration showing that brominated compounds form a large part of the chlorination roducts. The total halo-acetic acid concentration correlated positively with the chlorine-to-carbon ratio and with the adsorbable organic halogen, to which it accounted for 15%. (Author's abstract) W91-10938

ALGICIDAL AND CHEMICAL EFFECT OF U.V.-RADIATION OF WATER CONTAINING HUMIC SUBSTANCES,

Norsk Inst. for Vannforskning, Oslo. E. T. Gjessing, and T. Kallqvist. Water Research WATRAG, Vol. 25, No. 4, p 491-494, April 1991. 2 fig, 1 tab, 4 ref.

Descriptors: \*Algicides, \*Chemical properties, \*Disinfection, \*Humic substances, \*Ultraviolet radiation, \*Water treatment, Acidic water, Algal growth, Drinking water, Microorganisms, Organic matter, Ozone.

Ultraviolet (UV) radiation is increasingly used to disinfect drinking water. In addition to an effect on microorganisms, both artificial and natural UV-radiation transforms chemicals in water. The effect of UV on humie substances (HS) in water acquires increasing relevance because of the anticipated increase in global radiation, as a consequence of the reduced ozone content in the stratosphere. Experiments were conducted using typical surface water with humic substances. The results show that UV-radiation of humus water changes the chemical composition of water, including acidity and charge density and also inhibits the growth of the alga Selenastrum capricornutum. Inhibition increases with increased 'UV-dose' from a mercury lamp. The algicidal effect apparently lasts for several weeks. The observed action of UV-treated humus water may be explained by photon-initiated interactions of HS and other chemicals in the water which results in the formation of oxidizing reagents such as OH radicals; these in turn oxidize organic materials by hydrogen abstraction. (Author's abstract)

ANALYSIS OF LARGE SCALE WATER DISTRIBUTION SYSTEMS.

Akron Univ., OH. Dept. of Civil Engineering. S. Sarikelle, and Y. Chuang. Journal of Hydraulic Research JHYRAF, Vol. 29, No. 1, p 5-13, 1991. 2 fig, 4 tab, 13 ref.

Descriptors: \*Flow models, \*Hydraulic design, \*Hydraulic engineering, \*Model studies, \*Water conveyance, \*Water distribution, Computer models, Computer programs, Computing time, Conveyance structures, Pipes, Simulation analysis.

A variety of methodologies is currently available for computing flows in water distribution systems. One the these methods is the Newton-Raphson Method which regenerates and factorizes Jacobian matrix at each iteration. In this method a great deal of computational effort is consumed in the determination and factorization of the Jacobian matrix. One alternative approach is to use the initial Jacobian matrix throughout, thus avoiding the expense of reforming and triangularizing the Jacobian matrix. However, in this approach, the quadratic convergence characteristic of the Standard Newton-Raphson Method is no longer maintained. As a compromise between these two approaches, a

### Group 5F—Water Treatment and Quality Alteration

class of methods known as Quasi-Newton Methods can be utilized. A computer model has been devel-oped which incorporates the use of Quasi-Newton Methods in the solution of large scale water distribution systems. Three water distribution systems of varying sizes were analyzed using this method. The computer results obtained using the Quasi-Newton Raphson Method were compared to those obtained by the Standard Newton Raphson Method. The results show that the Quasi-Newton Method allows substantial saving of central processing unit (CPU) time, particularly if continuous simulation studies (time extended) of the distribution systems are undertaken, and is efficient in handling large scale water distribution systems. (Author's abstract) W91-10983

REMOVAL OF BIOTA FROM INTER-BASIN TRANSFER WATER. North Dakota Univ., Grand Forks. Dept. of Civil

Engineering.
C. D. Turner, and M. Hefta.
IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 129-138, 4 fig,

Descriptors: \*Biological studies, \*Ecological effects, \*Hudson Bay Watershed, \*Interbasin transfers, \*Missouri River Basin, \*Water quality control, \*Water resources development, \*Water treatment, Case studies, Filtration, Garrison Diversion Project, North Dakota, Pathogens, Turbidity, Water treaffer.

The potential transfer of biota from the Missouri River Basin into the Hudson Bay Basin has become the central argument for not diverting water via the Garrison Diversion Project in North Dakota into either the Sheyenne River drainage or the Devils Lake Basin. Both the Sheyenne River and Devils Lake drain into the Red River of the North which enters Canada via Manitoba and eventually empties into the Hudson Bay. Earlier efforts to design an effective barrier to biota transfer were reviewed along with an examination of current research efforts to design a cost-effective system for biota removal. Early efforts involved the design and testing of fish screens by the US Bureau of Reclamation. Current efforts center around direct filtration, a potable water treatment method suitable for treating raw water with low turbidity. suitable for treating raw water with low turbidity.

A direct filtration process development unit (PDU) was operated in the laboratory using synthetic Garrison water and subsequently moved to Garrison for on-site testing. Test results indicate that direct filtration is suitable for use with Garrison. raw water and that the fish pathogen, Yersinia ruckeri, can be effectively destroyed using post-disinfection. (See also W91-11003) (Author's abstract) W91-11017

HOME WATER TREATMENT: REMEDIATING ALDICARB CONTAMINATION IN SUFFOLK COUNTY, NEW YORK. Suffolk County Dept. of Health Services, Haup-

pauge, NY. D. Moran.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 291-299, 2 tab.

Descriptors: \*Aldicarb, \*Granular activated carbon, \*New York, \*Nonpoint pollution sources, \*Pesticides, \*Water quality control, \*Water treatment, \*Well water, Drinking water, Groundwater pollution, Pesticide residues.

Pesticide contamination was first discovered in Suffolk County in August 1979 when the carba-mate pesticide aldicarb (Temik) was detected in drinking water supply wells. As a result of this finding, an extensive testing program for aldicarb and other carbamate pesticides was initiated. The testing program revealed that extensive contamination of groundwater resources had occurred in the agricultural areas of eastern Suffolk County. Reediation involved the use of granular activated

carbon (GAC) treatment units in homes with wells containing aldicarb residues above 7 ppb. Based upon eight years of experience it has been found that the home treatment program is a viable option to address the aldicarb contamination problem. It must be realized that implementation of such a program involves significant operation, mainte-nance, and administrative efforts. Responsible ac-tions on the part of the pesticide manufacturers in providing support have contributed to the success of the program. (See also W91-11162) (Korn-PTT) W91-11189

WATER AND HUMAN HEALTH.
Johns Hopkins Univ., Baltimore, MD. School of Engineering. A. Wolman.

A. Wolman.

IN: A 25th Anniversary Collection of Essays by Eminent Members of the American Water Resources Association. AWRA Special Publication No. 89-2. American Water Resources Association, Bethesda, Maryland. 1989. p 31-40. 6 ref.

Descriptors: \*Developing countries, \*Drinking water, \*Human diseases, \*Public health, \*Sanitation, \*Water quality control, Africa, Economic aspects, Social aspects, Water conservation, Water pollution, Water resources management.

The objectives of the International Water and Sanitation Decade, 1980-1990, are lofty-safe drinking water for all. Predictably, water has been delivered and excreta have been removed for large numbers of people hitherto unserved. Coverage, however, has not been universal. Preparation for implementation of projects has taken longer than was hoped. The americas have the oldest orga-nized approach to the issues. Africa, on the other hand, has emerged only within the last half a century with deliberate public health programs. Of the may constraints to safe drinking water, four are outstanding: lack of motivation, inadequate personnel, poor management, and shortage of money. Greater emphasis should be placed on using local money, local institutional structures, and most importantly, local people. Education and leadership may most effectively come from an underused source--local women. Diseases that affect humans appear in three categories: (1) diseases carried by water; (2) water-based diseases, whose infecting agents develop in aquatic animals; and (3) diseases agents develop in aquatic animals; and (3) diseases related to poor sanitation and insufficient water for proper hygiene. Successes in the prevention and virtual elimination of communicable diseases were great in the western world. The picture in developing countries remains dismal. By the year 2000, conservation of water resources will have to include reuse of treated sewage and the application of a closed cycle of water use in municipalities and industries. Manmade and natural chemicals are the most recent threat to the water supply. The chalmost recent threat to the water supply. The challenge ahead in the water management field is par-ticularly difficult, because the manifestation of in-sults to water has been going on for decades. (See also W91-11206) (Mertz-PTT) W91-11211

BUBBLELESS AERATION.
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering. For primary bibliographic entry see Field 5G. W91-11222

PACKAGE WATER PLANT FILTERS TO 0.02

June Lake Public Utility District, CA.

Water Engineering and Management WENMD2, Vol. 138, No. 4, p 28-29, April 1991. 1 ref.

Descriptors: \*Filters, \*Giardia, \*Viruses, \*Water treatment, California, Cost analysis, Filtration, Flocculation, June Lake, Performance evaluation, Turbidity, Water quality management.

Removing Giardia cysts and viruses from cold, clear, pristine waters can be difficult. At June Lake, California, waters of turbidity < 0.2 nephelometric turbidity units (NTU), 32-45 F, and total dissolved solids < 100 mg/L, little or no color,

and no appreciable iron-manganese are used for water supply. A treatment plant at a remote loca-tion was designed that specified dual process trains rate for 120 gpm each (manufactured by Culligan). The process trains include two 6 ft-diameter floc-culator vessels followed by their respective 7 ft-diameter filter vessels. The flocculation vessels are diameter litter vessels. In the footcomment vessels are popy-lined tanks full of coarse monomedia (= contact floculators or clarifiers). Coagulant mixing occurs within the clarifiers. The floculator units remove most of the raw water particulate units remove most of the raw water particulate load and they simultaneously condition water for filtration. Typically the effluent turbidity of the process falls well under 0.1 NTU, at times as low as 0.02 NTU, even with raw water values above 5 NTU for short periods. Filter backwash, concurrent with flocculator backwash, usually is required only bi-weekly or even less frequently based on head loss. The unit and appurtenances was delivered for \$100,000, which works out to \$300/gpm of true) process canactive exclusive of housing. of (true) process capacity, exclusive of housing, piping the units to the exterior piping system and process monitoring instrumentation (i.e., turbidimeters). (Rochester-PTT)

CAPILLARY COLUMN GAS CHROMATOGRA-PHY WITH NITROGEN-PHOSPHORUS DE-TECTION FOR DETERMINATION OF NITRO-GEN-AND PHOSPHORUS-CONTAINING PES-TICIDES IN FINISHED DRINKING WATERS: COLLABORATIVE STUDY.

Bionetics Corp., Cincinnati, OH. For primary bibliographic entry see Field 5A.

DIRECT AQUEOUS INJECTION-LIQUID CHROMATOGRAPHY WITH POST-COLUMN DERIVATIZATION FOR DETERMINATION FN-METHYLCARBAMOYLOXIMES AND N-METHYLCARBAMATES
DRINKING WATER: IN FINISHED COLLABORATIVE DRINKING STUDY.

Bionetics Corp., Cincinnati, OH. For primary bibliographic entry see Field 5A. W91-11260

DETERMINATION OF NITROAROMATICS AND NITRAMINES IN GROUND AND DRINK-ING WATER BY WIDE-BORE CAPILLARY GAS CHROMATOGRAPHY. Army Environmental Hygiene Agency, Aberdeen Proving Ground, MD. Organic Environmental Chemistry Div

Chemistry Div.

For primary bibliographic entry see Field 5A. W91-11262

FLOCCULATION OF MICRO-ORGANISMS. Wahnbachtalsperrenverband, Siegburg (Germany, F.R.).

H. Bernhardt, and J. Clasen. Aqua AQUAAA, Vol. 40, No. 2, p 76-87, April 1991. 17 fig, 43 ref.

Descriptors: \*Flocculation, \*Particulate matter, \*Water treatment, Aluminum salts, Electrical charge, Electrochemistry, Iron salts, Microorganisms, Plankton, Polymers

The removal of microorganisms by flocculation and filtration is one of the major problems in treating reservoir water, especially if the water shows a very high plankton production due to eutrophication. Flocculation of algae and bacteria conforms in principle to an adsorption coagulation with charge neutralization, provided that the cells of both bacteria and algae are smooth and more or less spherical. There is a stoichiometric relationship between the total surface area of the particle ship between the total surface area of the particle (surface concentration), i.e., the cell concentration, and the chemical dosage required for the floccula-tion process. The effects of differently charged organic polyelectrolytes and polymers on the floc-culation process were examined and their influence was compared with that of inorganic iron and aluminum salts, which form differently charged polyhydroxo complexes during hydrolysis depend-ing on the flocculation pH value. The elimination

### Water Treatment and Quality Alteration—Group 5F

of planktonic cells depends strongly on the type of plankton present and varies from 50 to 99.9%. The required flocculant dose of cationic polyelectrolytes or positively charged metal hydroxo complexes is markedly determined by the amount of negative charge density of the algae and their growth phase. Filamentous algae, large algae, or species with bristles on their cell surface do not too from to the stoichingteric rules. A satisfactory species with bristles on their cell surface do not conform to the stoichiometric rules. A satisfactory flocculation of these algae will be possible only if large amounts of aluminum hydroxide flocs are produced in the water that then enclose the algal cells (sweep coagulation). Planktonic motile organisms are a problem in flocculation and filtration because they can break away easily from produced flocs. The inactivation of their motility is indispensible if flocculation and floc separation is to be flocs. The mactivation of their motility is indispen-sable if flocculation and floc separation is to be improved. Methods to accomplish this inactivation include use of oxidizing agents such as ozone, potassium permanganate, chlorine, or chlorine di-oxide. (Rochester-PTT) W91-11267

EFFICIENCY OF AN OZOFLOTATION-FIL-TRATION PROCESS FOR THE TREATMENT OF THE RIVER THAMES AT WALTON WORKS.

WORKS.
Anjou Recherche, Maisons-Laffitte (France). Lab. d'Hygiene et Recherche en Sante Publique.
M. M. Bourbigot, N. Martin, M. Faivre, K. Le Corre, and S. Quennell.
Aqua AQUAAA. Vol. 40, No. 2, p 88-96, April 1991. 8 fig, 9 tab, 5 ref.

Descriptors: \*Filtration, \*Ozoflotation, \*Ozona-tion, \*Water treatment, Algae, Chlorophyll, Disin-fection, England, Organic matter, Ozone, Perform-ance evaluation, Sand filters, Thames River, Tur-bidity, Walton Works.

The current treatment of Thames River water (England) at Walton Works is conventional. After tengiand) at waiton Works is conventional. After settlement, with or without pretreatment, the water flows to the primary rapid filters. The primary filtrate then flows to secondary slow-sand filters. The secondary filtrate is passed to a contact tank for disinfection. To improve the current water treatment (high algal content currently causes taste and odor problems and close filtrate), the combiner treatment (high algal content currently causes taste and odor problems and clogs filters), the combination of ozoflotation with filtration was tested in a pilot plant. The ozoflotation process is a combination of pre-ozonation treatment and conventional flotation. It associates the physical aspects of flotation with the oxidation effects of ozone. The pilot plant included the ozoflotation unit with two combinations with the ozoflotation unit with two combinations are proposed to the open or problems. partments and two filters that work in parallel. A total of 7.5 min contact was used in the two compartments of the ozoflotation contactor. After compartments of the ozoflotation contactor. After ozoflotation, water was passed either through a granulated-activated carbon (GAC)-sand filter or a plain sand filter. Based on the results of several tests carried out with this pilot plant, the following conclusions were drawn: (1) water quality is better with ozoflotation and filtration than with direct filtration; (2) the GAC-sand filter showed better performance than the sand filter (with regard to color, UV 254 mm an 270 mm, turbidity, organic matter, chlorophyll, algae, and head loss); (3) algal elimination due to ozoflotation equals or exceeds algal elimination at the outlet of direct sand filtration; (4) ferric chloride used as a flocculating agent allows better water quality and a better filter peruon; (9) rerrie enioride used as a flocculating agent allows better water quality and a better filter per-formance than polyaluminum chloride; and (5) sweeping of the porous plates is essential to obtain good water quality and satisfactory filter perform-ance. (Rochester-PTT) W91-11268

CRITERIA FOR FLOCCULATOR DESIGN. Hokkaido Univ., Sapporo (Japan). Dept. of Envi-ronmental and Sanitary Engineering. N Tambo

Aqua AQUAAA, Vol. 40, No. 2, p 97-102, April 1991. 6 fig, 15 ref.

Descriptors: \*Design criteria, \*Flocculation, \*Water treatment, \*Water treatment facilities, Energy, Mathematical equations, Performance tion, Sanitary engineering.

In 1953, the practical use of the mean velocity gradient G-value and non-dimensional GT-value

theory for flocculator design to make better flocs theory for flocculator design to make better flocs was proposed. Subsequently, it was proposed that non-dimensional product GC sub 0T determines the progress of flocculation rather than GT value. (G is the mean velocity gradient of the agitation field (I/s), C sub 0 is the initial volume concentration of flocs (non-dimensional), and T is the elapsed time for flocculation.) The value of G etapsed time for inoccutation.) The value of G = the square root of epsilon/mu, in which epsilon is the total mean dissipation of energy (watts/cu m) and mu is the absolute viscosity (Pa . second). Flocculation kinetics are summarized here and a set of practical design criteria is proposed, that is, G and the GC sub 0T values. The use of GC sub of an the GC sub of values. The use of GC sub off = 1.0 is proposed as the criterion to reach an ultimate floc growth rate in a conventional flocu-lator followed by sedimentation. For another kind of floculator design applied for a direct filtration that needs only a small increase in floc size, a much higher GC sub off value, such as 5, is recommended. (Author's abstract) W91-11269

USE OF A BACKFLUSH TECHNIQUE IN CROSS-FLOW MICROFILITRATION FOR TREATING NATURAL WATER AND FILTER BACKWASH WASTEWATER IN WATER

Asian Inst. of Tech., Bangkok (Thailand). Div. of Asian inst. of rech., Bangkok (Thanand). Div. of Environmental Engineering. S. Boothanon, H. Prasanthi Dharmappa, S. Vigneswaran, and R. Ben Aim. Aqua AQUAAA, Vol. 40, No. 2, p 103-109, April 1991. 5 fig, 3 tab, 3 ref.

Descriptors: \*Backflushing, \*Filtration, \*Potable water, \*Wastewater treatment, \*Water treatment, Backwash wastewater, Cross-flow microfiltration, Water treatment facilities.

Cross-flow microfiltration (CFMF) is useful in Cross-flow micronitration (CFMF) is useful in treating natural water for potable purposes, be-cause it is very efficient in completely removing all particles within the size range 0.01 to 10 microme-ter, including bacteria. It also can be used to treat the filter backwash wastewater produced in a water treatment plant. Although CFMF is a very water treatment plant. Although CFMF is a very effective technique for treating natural water and filter backwash wastewater, problems such as fouling, deposition, and internal clogging affect the efficiency of the process. The backflush technique in CFMF is one of the most useful techniques for minimizing these problems. Laboratory-scale CFMF experiments were conducted using the backflush in treating natural water and filter backwash wastewater to study the effect of operating parameters, such as backflush frequency and backflush duration, on CFMF performance. For natural water treatment, the permeate flux increased by water treatment, the permeate flux increased by 24% when the backflush technique was used and 24% when the backflush technique was used and for backwash wastewater treatment it increased by 400%. The low turbidity (0.1-0.3 NTU) of the permeate proves the applicability of CFMF to potable water treatment. When filter backwash wastewater was used as feed, the optimum backflush frequency and backflush duration for obtaining maximum flux were 1 min and 2 sec, respectively. The flux of 1.175 cu m/sq m per hachieved here is a breakthrough in membrane process technology (Author's sharter) cess technology. (Author's abstract)

CRYPTOSPORIDIOSIS AND WATER SUPPLY: A BRIEF REVIEW, WITH SPECIAL REFERENCE TO THE REPORT OF THE BADENOCH COMMITTEE. North Surrey Water Co., Staines (England).

J. Jeffery. Aqua AQUAAA, Vol. 40, No. 2, p 110-115, April 1991. 15 ref.

Descriptors: \*Cryptosporidium, \*Drinking water, \*England, \*Human diseases, \*Water treatment, Badenoch Committee, Chlorine dioxide, Epidemics, History, Ozone, Public health.

Awareness of the pathogenic significance of Cryptosporidium and of the possibility of waterborne infections has increased rapidly during the 1980s. Following an outbreak of cryptosporidiosis in Swindon (England) and parts of Oxfordshire early

in 1989, the British Government set up a group of experts under the chairmanship of Sir John Badenoch to advise on Cryptosporidium and water supplies. Information on Cryptosporidium, including the organism's characteristics, recorded outbreaks of Cryptosporidium, and the implications of this or Cryptosportalum, and the implications of this organism in water treatment is reviewed based on material from the Badenoch committee report. Consequences of events in 1989-1990 that affected the North Surrey Water Company also are described. Nine thousand cases of cryptosportidoss were reported in Britain in 1989. Water treatment processes generally were not designed to deal with occysts, which generally are unaffected by doses of chlorine considerably higher than those used in water treatment. A safe and effective disinfectant is needed; preliminary results suggest that ozone or chlorine dioxide may suffice, but more work is needed. Until an effective disinfectant is found, the needed. Only an effective dismerciant is found, the passage of occysts into the water supply will be prevented by catchment control and by skilled operation at maximum efficiency of existing treat-ment systems. (Rochester-PTT) W91-11271

SITUATION OF WATER SUPPLY IN THE NEW LANDER OF THE FEDERAL REPUBLIC OF GERMANY.

I. W. Merkel. Aqua AQUAAA, Vol. 40, No. 2, p 116-119, April 1991. 1 fig, 1 tab.

Descriptors: \*Drinking water, \*Germany, \*Governmental interrelations, \*Public health, \*Wastewater pollution, \*Water treatment, Facilities management, Management planning, Nitrates, Public policy, Wastewater treatment facilities, Water quality standards, Water use.

Since November 1989, when the Berlin Wall was Since November 1989, when the Berlin Wall was destroyed, steady progress was made toward German unification. Now that unification has taken place, the task remains of bringing public services in the former East Germany up to the levels attained in West Germany. The former German Democratic Republic had a surface area of 108,000 sq km, 16.5 million people, and a water use (not including power production) of 8.2% of the runoff. Comparable figures for the Federal Republic of Germany arise to unification were the runoff. Comparable figures for the Federal Republic of Germany prior to unification were: 249,000 sq km, 62.5 million people, and 15% of runoff. In the 'new areas' of Germany (the former eastern portion), 72.5% of the population is connected to sewage systems and 58% is connected to a sewage treatment plant. Much of the industrial wastewater, however, has no treatment at all. Eighteen percent of observation wells are polluted or endangered by nitrates. Fifteen percent of the or endangered by nitrates. Fifteen percent of the drinking water supply is usable with conventional treatment and 38% is usable with advanced treatment, but 47% is unusable. Ninety-three percent of the population (15 million) is connected to a public water supply, but 7.6 million receive drinking water that does not meet all standards. Water and sewage agencies have been restructured into pri-vate form (joint stock companies, limited companies). Priorities have been set to update the out-moded technology and to improve water quality. moded technology and to improve water quanty. Some pollution standards (e.g., cadmium, lead, nitrate, iron, and pesticides) have been suspended for periods varying from 1-5 yr because it is impossible to achieve immediate compliance. Microbiological requirements will be attained first, ultimately reaching the microgram level. (Rochester-PTT) W91-11272

NEW STANDARDS FOR THE DETERMINA-TION OF GEOSMIN AND METHYLISOBOR-NEOL IN WATER BY GAS CHROMATOGRA-PHY/MASS SPECTROSCOPY.

Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water

For primary bibliographic entry see Field 5A.

CHANNEL TUNNEL AND ITS IMPACT ON THE FOLKESTONE AND DISTRICT WATER COMPANY.

### Group 5F-Water Treatment and Quality Alteration

For primary bibliographic entry see Field 4C. W91-11363

INVESTIGATIONS WITH ELECTRODIALYSIS REVERSAL FOR THE TREATMENT OF SURFACE WATER TO MAKE-UP WATER.
Utrechtseweg 310, 6812 AR, Arnhem, The Neth-

erlands.
G. D. Enoch, P. Tigchelaar, J. de Niet, and J. B.

Lefers.

Separation Science and Technology SSTEDS, Vol. 25, No. 13/15, p 1387-1406, 1990. 6 fig, 10 tab,

Descriptors: \*Boiler water, \*Desalination, \*Electrodialysis, \*Industrial water, \*The Netherlands, \*Water treatment, Ion exchange, Separation tech-

Due to the high expense of tap water in some parts of the Netherlands, the use of treated surface water as boiler make-up water was investigated using an electrodialysis reversal process. Pilot scale studies were carried out using water from the North Sea Canal and Rhine River. Pretreatment of the surface water to remove suspended matter was per-formed by simple filtration with a multi-media filter or a sand filter followed by filtration with an activated carbon filter to remove oily substances.

Desalination was by electrodialysis reversal. Posttreatment was by means of ion exchangers to remove residual salts, silicate and organic compounds. During the operating period, no mem-brane fouling occurred with either canal or river water. Economic evaluations based upon the situa-tion of a powerplant located at the North Sea Canal indicated a pay back period for an installa-tion with a production capacity of 20 cu m/hr of about 6.5 yr. (Geiger-PTT) W91-11368

EVALUATING AERATION TECHNOLOGY FOR RADON REMOVAL. American Water Works Service Co., Voorhees,

K. L. Dixon, R. G. Lee, J. Smith, and P. Zielinski. Journal of the American Water Works Association JAWWA5, Vol. 83, No. 4, p 141-148, April 1991. 8 fig. 11 tab, 13 ref.

Descriptors: \*Aeration, \*Radon, \*Water treatment, \*Well water, Comparison studies, Mainte-nance, Packed tower aeration, Pennsylvania, Per-formance evaluation, Spraying, Wells.

Spray jet aeration, packed tower aeration, and multistaged bubble aeration were evaluated for the removal of radon from water, using water drawn from wells in service districts of the Pennsylvania-American Water Company. The spray jet aeration system did not exceed 75% radon removal; variations in air-to-water ratio had a negligible effect on radon removal efficiency and the orifices of the on radon removal efficiency and the orifices of the spray jet unit are susceptible to clogging resulting decline in removal efficiency. Frequent maintenance of the unit is indicated. For these reasons, the spray jet unit is not considered suitable for radon removal applications. Packed-tower aeration was found to be a very effective and flexible mechanism for radon removal, with removal efficiency was largely a function of packing height. Based on experience to date, maintenance of packed towers is expected to be minimal, but because of its relatively high profile, a PTA may not be suitable in communities where esthetics are a primary con-cern. The multistaged bubble aeration system is a effective and flexible means of radon remov al. Current design limits the system to wells with al. Current design limits the system to wells with capacities of 800 gpm or less if removal efficiencies >95% are necessary. For systems requiring lower removal efficiencies (<85%), the current design is capable of treating up to 1,800 gpm. Minimal maintenance is expected with this system ado because the units can be enclosed within a well house, they may be particularly suited to sites where esthetics are of primary concern. (Doria-PTT) W91-11462

MEASURING LOW RADON LEVELS IN DRINKING WATER SUPPLIES.

Maine Univ., Orono. Dept. of Civil Engineering. For primary bibliographic entry see Field 5A. W91-11463

RADON IN HOMES FOLLOWING ITS REDUCTION IN A COMMUNITY WATER

Maine Medical Center, Portland. Dept. of Re-

For primary bibliographic entry see Field 5B. W91-11464

FORMATION OF CHLOROPHENOLS AND RELATED COMPOUNDS IN NATURAL AND TECHNICAL CHLORINATION PROCESSES. Linkoeping Univ. (Sweden). Dept. of Water and Environmental Research.

For primary bibliographic entry see Field 5B. W91-11508

DESIGN AND PERFORMANCE OF THE BIO-FISH WATER RECIRCULATION SYSTEM. Norsk Hydroteknisk Lab., Trondheim. For primary bibliographic entry see Field 5D. W91-11548

EVALUATION OF SITE-SELECTION CRITE-RIA, WELL DESIGN, MONITORING TECH-NIQUES, AND COST ANALYSIS FOR A GROUND-WATER SUPPLY IN PIEDMONT CRYSTALLINE ROCKS, NORTH CAROLINA. For primary bibliographic entry see Field 2F.

### 5G. Water Quality Control

IMPACT OF CHANGING REGIONAL EMIS-SIONS ON PRECIPITATION CHEMISTRY IN THE EASTERN UNITED STATES.

New York Botanical Garden, Bronx, NY. Inst. of Ecosystem Studies

T. J. Butler, and G. E. Likens.

Atmospheric Environment ATENBP, Vol. 25A, No. 2, p 305-315, 1991. 4 fig, 3 tab, 44 ref. DOE contract no. DE-FG02-88ER60292.

Descriptors: \*Acid rain, \*Chemistry of precipita-tion, \*Nitrogen oxides, \*Precipitation, \*Sulfur di-oxide, \*Water pollution prevention, \*Water pollu-tion sources, Air pollution, Illinois, New Hamp-shire, New York, Ohio, Pennsylvania, Sulfates.

From 1975 to 1987 a 19% change in SO2 emissions and a 16% change in NOx emissions have occurred over the eastern and mid-western U.S. Six continental precipitation chemistry sites from the MAP3S network, plus the Hubbard Brook Experiment Forest, NH, show a direct relationship between emission levels and precipitation H(+) and SO4(2-) concentrations, except for Penn State, PA. MAP3S sites at Illinois and Ohio, located closest to MAP3S sites at Illinois and Ohio, located closest to the major SO2 source regions, demonstrate statistically significant linear regressions of SO4(2-) concentrations on SO2 emissions. Whiteface Mountain, NY, shows a weaker relationship, and Hubbard Brook shows the strongest relationship between SO2 emissions and SO4(2-) concentration in precipitation. No site shows a significant relationship for NOx emissions and NO3(-) concentrations in precipitation. Illinois, Ohio, Ithaca and Hubbard Brook show significant linear repressions of H(-1) Brook show significant linear regressions of H(+) concentrations on emissions of SO2 + NOx. Overconcentrations on emissions of SO2 + NOx. Overall, for the entire region examined, decreasing SO2 emission levels appear to have decreased  $SO4(2\cdot)$  concentrations with an efficiency of 74% + /+15%. Decreasing SO2 plus NOx emissions (18%) have been accompanied by a decreasing H(+) concentration (18%) suggesting an efficiency of conversion of 100% + /-15% for the study region as a whole. While significant reductions in acid species have occurred at Hubbard Brook, further reductions in excess of 50% of present deposition are necessary to protect acid-sensitive ecosystems. (Author's abstract) W91-10473

PROPERTIES OF LINEAR PROGRAMMING MODELS FOR ACID RAIN ABATEMENT. Meteorologischer Dienst der DDR, Potsdam

Atmospheric Environment ATENBP, Vol. 25A, No. 2, p 401-410, 1991. 7 fig, 4 tab, 11 ref.

Descriptors: "Acid rain, "Air pollution control, "Computer programs, "Cost analysis, "Model studies, "Water pollution prevention, Computers, Deposition, Linear programming, Mathematical studies" ies, Optimization, Sensitivity analysis.

Several properties were established for linear programming problems arising in the field of acid rain abatement (in the case of a linear source-receptor relationship and linear or piecewise-linear abatement cost functions). In the optimal solution, the number of sources that are not at an inflection point of the corresponding piecewise-linear cost function is equal to the number of binding environmental constraints. (Here inflection point denotes a noint where the piecewise-linear cost function mental constraints. (Here inflection point denotes a point where the piecewise-linear cost function changes its slope; an environmental constraint is called binding if, for the optimal solution, the calculated deposition is just equal to, and not less than, the constraint.) As a consequence, several sources have optimal memissions that get stuck at an inflection point. This influences the results of sensitivity analyses as well as the numerical accuracy of the optimal solution (if the piecewise-linear cost function has been obtained as a coarse approximation to a more complicated cost function). Moreover, for targets becoming more stringent, the optimum abatement costs may decrease for certain sources, although the total abatement costs increase. This rather unexpected effect indicates that pure optimization results should be applied that pure optimization results should be applied (for example, in negotiations) in a careful manner. (Author's abstract) W91-10477

LONG CLIMB TO REMEDIATION.

Civil Engineering (ASCE) CEWRA9, Vol. 61, No. 4, p 68-71, April 1991.

Descriptors: \*Cleanup operations, \*Hazardous waste disposal, \*Incineration, \*Military reservations, \*Waste disposal, \*Water pollution treatment, Ammonium, Brines, Colorado, Heavy metals, Military wastes, Organic compounds, Pesticides, Salts, Waste Treatment Waste treatment.

For 40 years, mustard gas, napalm, and pesticides were manufactured just 10 miles from downtown Denver at the Rocky Mountain Arsenal. Much of the chemical wastewater flowed to a 93 acre, 243 million gallon pond, built in 1956, creating a potent and unusual mixture of water, organics and dis-solved solids. A decade of studies and pilot pro-grams has finally lead to remediation through the use of a downfired liquid incinerator. Submerged quench incineration was chosen because it could completely destroy the highly sensitive organic components. The equipment can also continually purge itself of approximately 1,500 pounds/hour of salt and heavy metals; withstand the corrosive activity of the dissolved solids; and process very high amounts of ammonium nitrogen. During the community involvement program, area residents repeatedly questioned the fate of the incinerator's repeatedly questioned the late of the incherator's product brine. The brine was initially supposed to be dried and disposed of in an off-site landfill. In a significant decision, the EPA, the Army and the state of Colorado agreed to amend the incinerator program to include shipping of the liquid to an off-site commercial facility, which will remove the metal components by precipitation and recycle them at a commercial metals operation, leaving nothing to be disposed of on land. The only re-maining product will be clean salt water, free of both hazardous organics and toxic metals, to be discharged to a coastal salt-water receiving body.
(Mertz-PTT) W91-10483

GROUND WATER: HOW CONTAMINATED.

J. H. Lehr. Civil Engineering (ASCE) CEWRA9, Vol. 61,

### Water Quality Control-Group 5G

No. 4, p 72-73, April 1991.

Descriptors: \*Groundwater pollution, \*Water pollution control, \*Water quality, Agricultural chemi-cals, Environmental protection, Groundwater, Groundwater management, Industrial wastes, Landfills, Public policy, Safe Drinking Water Act, Septic tanks, Superfund, Underground storage tanks, Water conservation, Water law.

In spite of historical tendencies toward complex surface-water projects and a political climate that has spawned disincentives to conserve water and develop it economically, the world is at last on the right track toward balancing its water budget. Commonsense management techniques are the key to such a balance. Environmental protection is advancing as fast as possible, given current resources and the fact that such progress is locked into the pace of scientific, technical and institutional development. But politicians can demand an instant end to long-standing problems. They can promise more than any government agency can reasonably deliver. Groundwater has been protected through the amended Water Pollution Control Act of 1972, the Safe Drinking Water Act of 1974, half a dozen later acts and Superfund. Meeting the public's expectation of environmental cleanup is public's expectation of environmental cleanup is impossible. The risk has been distorted, and analytimpossible. The risk has been distorted, and analytical techniques are just too good. The public wants everything out, but tests will soon show contaminants in concentrations as low as a part per quadrissed in the past five years: landfills, agricultural chemicals, industrial waste lagoons, underground storage tanks, leaking pipelines, septic tanks and highway salting. Although the glacially slow movement of groundwater produces long-term problems, it also affords adequate time to achieve the most reasonable approach to managing these residual problems of the past. (Mertz-PTT) W91-1048

BOSTON'S SEWAGE OUTFALL. For primary bibliographic entry see Field 5D. W91-10485

AQUIFER RESTORATION: WHICH METHOD. B. T. Nolan, and G. D. Boardman. Civil Engineering (ASCE) CEWRA9, Vol. 61, No. 4, p 81-83, April 1991. 2 fig.

Descriptors: \*Aquifers, \*Cleanup, \*Groundwater pollution, \*Restoration, \*Water pollution preven-Descriptors: Adquiers, "Cleanup, "Orondwater pollution, "Restoration, "Water pollution preven-tion, "Water pollution treatment, Activated carbon, Aerobic treatment, Air stripping, Berms, Biological treatment, Chemical treatment, Dikes, Groundwater, Groundwater barriers, Physical

Groundwater contamination is an increasing problem, especially in large urban areas. Toxics that seep into water supplies threaten the health of the community, but engineers have various options at their disposal to deal with the problem. Remediation options include containment and physical, chemical and biological treatment. Containment techniques include impermeable and hydraulic bar-riers, and surface water and leachate controls. Impermeable barriers that contain, capture or redirect permeable barriers that contain, capture or redirect groundwater flow may be slurry walls, grout cur-tains or sheet pilings. Inexpensive slurry walls are the most common type. Surface water and leachate control systems manage surface water flows at waste disposal sites. System types include dikes, berms, terraces and benches to prevent or intercept runon/runoff; channels, waterways, chutes and downpipes to collect and transfer water; seepage basins and ditches to store and discharge it; and sedimentation basins and ponds. Physical treatment depends on the volatile, adsorptive and/or insolu-ble properties of the contaminant. Types include phase-separated hydrocarbon recovery, air strip-ping, activated carbon adsorption and filtration. Chemical treatment of groundwards mical treatment of groundwater includes coagulation-precipitation, redox reactions and neu-tralization. Biological treatment involves the microbial degradation of organics in a waste system. It is routinely used to remove organics from municipal and industrial wastewater, and can be used to treat groundwater that contains moderate levels of organics. Although biodegradation occurs in both aerobic and anaerobic environments, aerobic biotreatment is more common. Biotreatment techpiotreatment is more common. Biotreatment techniques applicable to hazardous wastes include activated-sludge processes and fixed-film processes such as rotating biological contactors and trickling filters. (Mertz-PTT) W91-10486

MATHEMATICAL MODELLING FOR RESERVOIR WATER-QUALITY MANAGEMENT THROUGH HYDRAULIC STRUCTURES: A CASE STUDY.

ENGE-RIO, Engenharia e Constuloria S.A., Rio

ENGE-RIO, Engenharia e Constutoria S.A., Rio de Janeiro (Brazii). M. C. Araujo Filho, J. A. O. De Jesus, J. M. Branski, and J. A. Macari Hernandez. Ecological Modelling ECMODT, Vol. 52, No. 1/ 2, p 73-85, November 1990. 6 fig, 3 tab, 7 ref.

Descriptors: \*Computer models, \*Model studies, \*Reservoir operation, \*Tropical regions, \*Water quality control, Amazon River, Hydraulic structures, Hydroelectric plants, Hydrologic models,

The U.S. Army Corps of Engineers' one-dimensional model (CE-QUAL-RI) was used to analyze the usefulness and feasibility of hydraulic structures in allowing management procedures for reservoir water-quality control. The model calculates the vertical hydrothermal and water-quality structure are fraction of inflowing waters meteoralthe vertical hydrothermal and water-quality struc-ture as a function of inflowing waters, meteorol-ogy and reservoir operation. It considers selective withdrawal as a result of the operation of spill-ways, intake for turbines and bottom outlets. The feasibility of a bottom outlet in altering water-quality tendencies of an Amazon hydroelectric quality tendencies of an Amazon hydroelectric power project (Cachoeira Porteira Reservoir) whose the filling is forecast for first half of 1995 was examined. In order to obtain more realism in respect to water-quality dynamics of Amazon reservoirs, some modifications were introduced to the original model version, which was also adapted to 16-bit microcomputer hardware. A large hydrological series of averaged monthly flow rates was studied and two semential years were chosen for studied, and two sequential years were chosen for obtaining a critical reservoir water-quality situa-tion. Field water-quality data from distinct hydrological periods were used, and daily local meteoro-logical information was considered. The simulations involved four hypotheses, with consideration of different flow rates through a bottom outlet. The alterations to reservoir water-quality tenden-cies were analyzed, emphasizing the intensity of cres were analyzed, emphasizing the intensity of stratification, eutrophication, and anoxic conditions caused by the flooding of natural vegetation. The results show the low influence of bottom outlet utilization in the specific case of Cachoeira Porteira Reservoir water quality. (Author's abstract)

LESSONS LEARNED FROM A THIRD WORLD WATER AND SANITATION PROJECT. For primary bibliographic entry see Field 5F. W91-10503

FACTA 1990 CONSERVATION AND ENVI-RONMENTAL HIGHLIGHTS.

VEBA Oel Technologie G.m.b.H., Gelsenkirchen (Germany, F.R.). W. L. Cohen, A. W. Hug, A. Taddese, and K. A.

Journal of Soil and Water Conservation JSWCA3, Vol. 46, No. 1, p 20-22, January/February 1991.

Descriptors: \*Agricultural practices, \*Agricultural water, \*Water law, \*Water policy, \*Water quality control, Conservation, Environmental protection, Food Agriculture Conservation and Trade, Groundwater protection, Water quality.

The Food, Agriculture, Conservation, and Trade Act (FACTA) of 1990, commonly called the 1990 farm bill, will form the statuatory foundation of U.S. agricultural policy for much of the coming decade. The law covers all of the traditional agricultural policy topics, from commodity price and income present to agricultural trade and from income support to agricultural trade, and from food stamps to research. Fourteen of FACTA's 25

titles deal directly with some aspect of natural resource conservation, environmental protection, or consumer issues. The Congress not only reau-thorized and modified the landmark 1985 Conservation Title, it also enacted new provisions dealing vation Itue, it also enacted new provisions dealing with water quality, pesticides, organic food, sustainable agriculture research, global warming, and other environmental topics. Title XIV of FACTA makes highly erodible set-aside land subject to conservation compliance; it also expands the list of programs to which compliance is tied. Concern programs to which compliance is tied. Concern about degradation of groundwater and surface water from farming activities dominated the 1990 farm bill. The most notable provision is the new Agricultural Water Quality Protection Program. This provision emphasizes water quality protection, including source reduction of agricultural pollutants. Furthermore, agricultural producers in environmentally sensitive areas should request assistance to develop and implement on-farm water maslity protection plans in order to assist in community protection plans in order to assist in comquality protection plans in order to assist in com-pliance with State and Federal environmental laws and to enhance the environment. (Mertz-PTT) W91-10507

POLLUTION AND PROTECTION OF BOHAI

POLLUTAGE AND SALVE ACADEMIC ACADEMICA AC

WATER QUALITY MANAGEMENT ISSUES IN LINGAYEN GULF, PHILIPPINES AND SOME PROPOSED SOLUTIONS,

International Center for Living Aquatic Resources Management, Manila (Philippines). F. Y. Guarin.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 19-23, 1991. 16 ref.

Descriptors: \*Coastal areas, \*Lingayen Gulf, \*Marine pollution, \*Path of pollutants, \*Philippines, \*Tourism, \*Water pollution control, \*Water pollution prevention, \*Water quality standards, Agricultural runoff, Domestic wastes, Education, Flow discharge, Microorganisms, Mine drainage, Regulations, Training, Wastewater disposal, Water pollution sources, Water quality monitoring, Water

Formulation and implementation of an integrated coastal area management plan in Lingayen Gulf, Philippines is necessary in light of increasing conflicts in use, resource depletion and degradation of water quality. Lingayen Gulf, a semi-enclosed body of water located in the northern part of the Philippines is a major fishing and tourist area in the country. The gulf is the catchment basin of major rivers in the region and consequently of the pollut-ants within the immediate vicinity. Pollution coming from point and non-point sources includes high levels of microbes from domestic sewage, fertilizers and pesticides from runoff, trace metals from mining activities, and siltation and sedimenta-tion from logging and mining operations and ex-plorations. Proposed solutions include the preparation of a master plan for a sewerage system; water unit of a master pair for a sewcage system, water quality monitoring of the six major river systems discharging in Lingayen Gulf; surveillance, en-forcement and monitoring of mining operations within the Baguio Mining District; epidemiological monitoring; establishment of a pilot solid waste disposal system for urban centers an upper water-shed management and rehabilitation plan an inforcampaign on environmental protection; and a training program to upgrade the technical capability of the research institutions and regulatory agencies within Lingayen Gulf. (Brunone-PTT) mation-education campaign on environmental pro-W91-10523

EVALUATION OF PRIMARY PRODUCTION LOADS AND THEIR CONTROL IN ENCLOSED SEAS.

Yamaguchi Univ. (Japan). Dept. of Civil Engineer-

### **Group 5G—Water Quality Control**

25-29, 1991, 4 fig. 5 tab. 4 ref.

Descriptors: \*Coastal waters, \*Eutrophication, Descriptors: "Coastal waters, "Eutropincation, Pollution load, "Primary productivity," Water pollution control, "Water pollution sources, Japan, Nutrient concentrations, Nutrient transport, Path of pollutants, Sewer systems, Wastewater treat-

Primary production in eutrophic water bodies contributes to water pollution, in the form of organic pollution. In order to evaluate the organic pollution load originated from primary production in an enclosed water body (the internal organic pollution load), many methods for evaluation have been proposed. Though strict evaluation of the internal organic pollution load is difficult, its approximate evaluation is possible. For the control of this interevaluation is possible. For the control of this mer-nal organic production, the reduction of inflowing nutrient levels, the eutrophic potential in each sea area is calculated with a simple procedure. Though nutrients are essential for biological production, their excess creates many water quality problems. Therefore, for the control of nutrient impacts to the enclosed coastal seas in Japan, the following strategies are proposed: (1) an effective measure for nutrient load reduction in their primary stage, for nutrient load reduction in their primary stage, as a consequence of structural analysis of nutrient budgets in Japan; (2) waste water treatment for nutrient load reduction; and (3) appropriate distribution of nutrient load impact based on the eutrophic potential of each coastal sea and each adjacent sea of Japan. The sewer and sewage treatment system is an effective system for reduction and distribution of the nutrient load. (Author's abstract) W91-10524

NORTH SEA STRATEGIES. Ministry of Transport and Public Works, The Hague (Netherlands). Tidal Waters Div. P. H. A. Hoogweg, K. J. Wulffraat, and B. G. M. van de Wetering. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 57-61, 1991. 3 fig, 2 tab, 4 ref.

Descriptors: \*Marine fisheries, \*Marine pollution, \*Marine transportation, \*North Sea, \*Path of pollutants, \*Resource allocation, \*Water pollution control, \*Water pollution sources, \*Water resources management, Chlorinated hydrocarbons, Ecosystems, Heavy metals, Pesticides, Regulations, Suspended solids, The Netherlands, Turbidity, Wetlands

The North Sea, with an area of about 575,000 sq km, has the most intensive traffic of any sea in the world, and fisherman land three billion kilograms of fish every year. While the Dutch coasts have valuable wetlands, thousands of tons of heavy metals, chlorinated compounds, nutrients and pesticides are emptied into this area every year. Turbid-ity in the North Sea has increased with increased suspended matter, damaging the ecosystems of the region. The overfishing (capture of nearly 25% of the total fish stock) every year makes the fishery non-sustainable. Due to the multifaceted use of the North Sea, sustainable development through regu-lation and future planning for reduction of pollu-tion loads and fishing levels will allow for contin-ued use of this resource. (Brunone-PTT) W91-10530

5-YEAR SCIENTIFIC RESEARCH PROGRAMME FOR MANAGING COASTAL SEAS.
Proudman Oceanographic Lab., Birkenhead (England).

For primary bibliographic entry see Field 2L. W91-10531

WATER QUALITY ASSESSMENT AND PRO-TECTION MEASURES OF A SEMI-ENCLOSED COASTAL AREA: THE BAY OF THERMAIKOS (NE MEDITERRANEAN SEA).

Thessaloniki Univ., Salonika (Greece). Lab. of Hydraulics and Hydraulic Works.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 83-87, 1991. 7 fig, 4 ref.

Descriptors: \*Greece. \*Marine pollution. \*Medi-\*Thermaikos Bay, \*Water pollution control, Coliforms, Industrial wastes, Model studies, Municipal wastes. Nutrients.

Twelve stations were sampled, over the time period 1984 to 1990, to monitor the water quality in the Thermaikos Bay area, Greece. The northern part of the bay, with a total surface area of 300 sq km and maximum depth of 30 m, is heavily pollut-ed by untreated sewage from the city of Thessaloniki and by industrial effluents. At all twelve sta-tions, temperature, salinity, pH, dissolved oxygen, nitrites, nitrates, ammonia, phosphates, silicates, heavy metals, total coliforms and Escherichia coli were measured in the water column in each season. Water pollution tends to increase from south to north and from the open sea to the estuaries of the Axios and Gallikos Rivers, reflecting river flow and the pollutant loads from human population in the northern region. The water-quality data used for assessing the environmental situation were employed to calibrate mathematical models which were then used to explore the efficiency of remedi al measures for the Bay of Thermaikos. Because of environmental concerns about water quality in the Axios River and the sea, operation of the new Thessaloniki city sewage system has been delayed for a year. It has been decided to impose further biological treatment of the wastewater. Meanolonogical treatment of the wastewater. Mean-while, discharge to the upper part of the Bay of Thermaikos is planned, using a ditch parallel to the Gallikos River. Mathematical modeling was used to study local environmental impacts in this area, especially concentrations of coliforms. (Brunone-PTT) W91-10534

STATUS OF EUTROPHICATION IN THE GREAT BARRIER REEF LAGOON.

Queensland Univ., Brisbane (Australia). Dept. of Chemical Engineering. For primary bibliographic entry see Field 5B. W91-10535

SEAGRASS-MANGROVE ECOSYSTEMS MAN-AGEMENT: A KEY TO MARINE COASTAL CONSERVATION IN THE ASEAN REGION. Philippines Univ., Diliman, Quezon City. Marine

ce Inst. M. D. Fortes.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 113-116, 1991. 21 fig.

Descriptors: \*Coastal environment, \*Coastal zone management, \*Conservation, \*Ecosystems, \*Envimanagement, Conservation, Ecosystems, Edityronmental policy, "Managrove swamps, "Sea grasses, "Water pollution control, Aesthetics, Economic aspects, Education, Erosion, Fisheries, Research, Sedimentation, Water resources management, and the search of th

Seagrass beds and mangrove forests are intimately linked by functional interactive processes which are as yet little understood. These high-order interactions form a major basis which justifies an inte-grated management scheme for the two ecosys-tems. However, while dominating enclosed coastal tems. However, while commaning encrosed coasial areas in the ASEAN region, sea grass and mangrove habitats are being degraded and destroyed at an alarming rate, raising serious doubt on their capacity for biological sustainability and normal recovery within this generation. An integrated approach toward seagrass and mangrove ecosystems management in the ASEAN region is outlined within a framework of known ecological principles. Proposed goals for seagrass and mangrove ecosystem management in the Philippines include the preservation of natural interconnections known in the ecosystems; protection of ecologically valuable and economically harvestable fisheries; protection of the coastline from erosion, siltation and pollution; establishment of seagrass and mangrove reserves for research and educational purposes; and preservation of aesthetic and recreational qualities of the natural shorelines. (Brunone-PTT)

PRESENT STATE OF ENVIRONMENTAL POLLUTION IN COASTAL SEA AREA AND MEASURES FOR PROTECTION. Institutul Roman de Cercetari Marine, Constanta

(Romania). For primary bibliographic entry see Field 5B. W91-10540

USE OF RESPIRATION IN THE SANDY BEACH OR ON THE TIDAL FLAT: 1, PERME-ABLE SANDY BEACH. Shin Nippon METOCEAN Consultant Co., Ltd., Edobori 3-2-23, Nishi-ku, Osaka, 550 Japan.

I. Sakamoto.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 123-130, 1991. 12 fig, 4 tab, 6 ref.

Descriptors: \*Beaches, \*Cleanup, \*Fate of pollutants, \*Respiration, \*Sediment-water interfaces, \*Site remediation, \*Water pollution treatment, Aerobic conditions, Bacteria, Microbial degradation, Mineralization, Sediment chemistry, Tidal

There are two types of beach respiration: the sandy beach type, in which air and seawater mix in the interstices of a permeable soil; and a tidal flat type, in which air and seawater mix on the surface of a nonpermeable soil. Both types are accordanced. of a nonpermeable soil. Both types are noted for the aerobic decomposition of rapidly mineralizing organic materials brought in by flood-tide water in the natural system. Sandy beaches are effective for the natural system. Sandy beaches are effective for the removal of dissolved organic loads, while tidal-flat beaches are more effective for trapping suspended particulates. Sandy beach respiration is carried out by microorganisms adhering to sand particles, while tidal flat beach respiration is carried out by burrowing macroinvertebrates. Study of the respiratory function of beaches has been intensified because of concerns about coastal water quality. It has been observed that heavy oils which drift ashore and are buried in sandy beaches are adsorbed on the sand grains and decomposed in situ. This phenomenon might be employed for the resorted on the sand grains and decomposed in stu.
This phenomenon might be employed for the remediation of accidental oil spills, using natural
beach sands. A further environmental benefit of
natural sandy beaches is in the final purification of effluents discharged from activated-sludge-process wastewater treatment facilities. Tidal rise and fall ensure periodic exposure of the partially-treated water to the natural bacterial ecosystem on the sand grains, and maintain aerobic respiratory conditions by periodically exposing the ecosystem to the atmosphere. (Brunone-PTT) W91-10541

SUMMARY OF PORTS AND MARINE ENVI-RONMENT IMPROVEMENT WORK AND EX-AMPLE OF LATEST MEASURES IN SETO INLAND SEA.

Ministry of Transport, Kobe (Japan). 3rd District struction Bureau.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 149-153, 1991.

Descriptors: \*Coastal zone management, \*Harbors, \*Japan, \*Marine pollution, \*Seto Inland Sea, \*Water pollution control, \*Water resources management, Chemical oxygen demand, Eutrophica-tion, Path of pollutants, Regulations, Sediment contamination, Site remediation.

Port and marine environmental improvement work in Japan began with the construction of waste oil disposal facilities in 1967 and port pollution prevention work in 1972. In the port and harbor areas of the Seto Inland Sea, transport and production of goods is extensive, resulting in increased inflow of goods is extensive, resulting in increased inflow of pollutants and environmental pollution. A plan for 'Ports in the 21st Century' was developed in 1985, calling for limiting of the functions of ports. Clean-up operations began in the early 1970's to remove floating refuse and oil in the inner seas and bays, noating retuse and oil in the inner seas and bays, such as Tokyo Bay, Ise Bay, and the Seto Inland Sea, under supervision of the government. At present, emergency dispatch systems for inland sea pollution are supervised by the District Port Construction Bureaus and the Maritime Safety Agency. In areas that are enclosed and have large cities located on their shores (such as the Seto Inland Sea), despite the implementation and strengthening of regulations governing effluent production from domestic and industrial sources on land, the situation has not improved. Red tides caused by eutrophication are still a common occurrence, as are bathing restrictions. Effective control measures include cleanup of the sea bottom, since organic pollutants can be dissolved into seawater from sludge. By covering the polluted sea bed with sand, bottom COD-containing areas were greatly reduced, and the numbers and wet weight of benthos increased. (Brunone-PTT)

RECOVERY OF AQUATIC ANIMALS IN DOKAI BAY, NORTHERN KYUSHU, JAPAN. Kitakyushu Municipal Inst. of Environmental

Health Sciences (Japan). M. Yamada, R. Takeuchi, S. Sueta, K. Kido, and

Y. Yabumoto.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 201-207, 1991. 3 fig, 1 tab, 10 ref.

Descriptors: \*Dokai Bay, \*Japan, \*Marine animals, \*Marine fisheries, \*Resource recovery, \*Water pollution control, Biological samples, Commercial fishing, Shrimp, Species composition, Surveys, Water pollution effects.

Dokai Bay, in northern Kyushu, Japan, used to be an excellent area for catching Kuruma prawn, with maximum landings recorded in 1928. Heavy water pollution from untreated domestic and industrial waste waters in Kitakyushu has caused widescale mortality of marine organisms. The fishermen of Dokai Bay had caught few fish since 1943. Since then, due to a successful attempt to decrease inflow of waste waters, the water quality of the bay has improved and commercial fishing of Kuruma prawn started again in 1983. Since 1988, aquatic animals have been sampled using gill nets and a small trawling net. One hundred and fifteen species of aquatic animals have been collected in these surveys: 65 species of fish, 37 species of arthropods, 12 species of mollusks, and 1 species of echinoderm. Almost all of these species were coastal-temperate species, and some were the same species reported in surveys before the pollution increase. Abundant species included Kuruma prawn, hardback shrimp, mantis shrimp, common goby, streaked goby, black porgy, and gizzard shad. Aquatic animals collected were abundant at all times of the year except in the summer at the inner part of the bay. Several species which had disappeared or were on the verge of extinction in 1933 were found in this recent survey. (Author's abstract)

STUDY ON MODEL REFERENCE ADAPTIVE WATER POLLUTION CONTROL IN ENCLOSED COASTAL SEA.

Hokkaido Univ., Sapporo (Japan). Graduate School of Environmental Science.

E. Yamamura, and M. Ota.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 379-382, 1991. 4 ref.

Descriptors: \*Coastal waters, \*Economic development, \*Marine pollution, \*Mathematical models, \*Model studies, \*Path of pollutants, \*Water pollution control. Comparison studies.

For pollution control in an enclosed coastal sea, the relationships were investigated between the economic activities on land and ecological activities in the enclosed coastal sea. Using Hermite Inverse Matrix Analysis, the balance of inter-field repercussions are shown through the total effects of inter-field propagation. Furthermore, to attain model reference pollution reduction, paths were evaluated which converge to the reference model. The adaptation processes of a system and its stability were tested by using Model Reference Adaptive Input-Output Methods. This model demonstrates the convergence between the reference model and the field results. (Author's abstract)

STRATEGIES FOR RESTORING AND DEVEL-OPING FISH HABITATS IN THE STRAIT OF GEORGIA: PUGET SOUND INLAND SEA, NORTHEAST PACIFIC OCEAN.

Department of Fisheries and Oceans, Vancouver (British Columbia). West Vancouver Lab.

C. D. Levings.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p
417-422, 1991. 1 fig, 22 ref.

Descriptors: \*Biotechnology, \*Coastal waters, \*Fisheries, \*Habitat restoration, \*Puget Sound, \*Strait of Georgia, \*Wetlands, Algal growth, Aquatic habitats, Environmental impact, Environmental monitoring, Industrial development, Riparian areas, Sea grasses, Sedges, Water quality monitoring.

Fish habitat rehabilitation and development in enclosed coastal seas is a relatively new branch of biotechnology that clearly requires further research. Rehabilitation and development of fish habitats are potential techniques for achieving sustainable development in coastal seas. Recent projects in the Strait and Puget Sound have used experiments with sedge marshes (Carex lyngbyei) in 26 sites and eelgrass beds (Zostera marina) in 14 sites. Some studies were appropriate for examining the potential compensation of wetland losses from industrial developments, but many were experimental and small-scale. More information is needed on the relative functional values of habitats such as sand and mud flats, algae beds, and riparian areas. Larger scale projects and longer term monitoring are needed to confirm that the policy goals of no net loss or net gain in fish habitat can be met using these techniques. (Brunone-PTT)

ASSESSMENT OF THE ENVIRONMENTAL CAPACITY OF ENCLOSED COASTAL SEA. Zagreb Univ. (Yugoslavia). Faculty of Civil Engi-

neering.
For primary bibliographic entry see Field 5E.

COUNTERMEASURES AGAINST WATER POLLUTION IN ENCLOSED COASTAL SEAS IN JAPAN.

Environment Agency, Tokyo (Japan). Water Pollution Control Div.

T. Hisano, and T. Hayase. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 479-484, 1991. 4 fig, 2 tab.

Descriptors: \*Coastal waters, \*Enclosed seas, \*Japan, \*Pollution load, \*Water pollution control, \*Water pollution sources, Anoxic conditions, Aquatic animals, Aquatic plants, Chemical oxygen demand, Eutrophication, Industrial wastewater, Mortality, Nutrient concentrations, Regulations, Seasonal variation, Species diversity, Tokyo Bay, Water exchange, Water quality standards, Water resources management.

Careful attention is necessary to control the water quality of enclosed water bodies such as inner seas and bays, because they have little ability to exchange water with the open sea and pollutants are easily accumulated. In Tokyo Bay, which receives many sources of inland pollution, organic pollution is conspicuous. Many kinds of benthic organisms living at the bottom of the inner part of the bay decrease in the summer, when a thermocline is formed. Anoxia is considered to be closely related to this increased mortality. The amount of pollution load from industrial sources has been decreasing as a result of implementing stringent effluent controls, such as setting up areawide total pollutant load control standards establishing maximum permissible limits of pollutant loads derived from industry. However, to further improve water quality, further efforts must reduce the total pollutant load. To reduce eutrophication in these water bodies, the nutrient load as well as the COD load must be reduced. In 1978, the law concerning Special Measures for Conservation of the Seto Inland Sea was set up, which includes new provisions for the prevention of the cocurrence of damage from eutrophication. (Brunone-PTT)

### Water Quality Control—Group 5G

ENVIRONMENTAL MANAGEMENT OF THE SETO INLAND SEA.

Hyogo Prefectural Public Health and Environment Dept., Kobe (Japan). H. Yasui, and E. Kobayashi.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 485-488, 1991.

Descriptors: \*Inland seas, \*Japan, \*Seto Inland Sea, \*Water pollution control, Conservation, Economic development, Environmental monitoring, Human population, Industrial development, Population density, Wastewater pollution.

The Seto Inland Sea, the largest inland sea in Japan, is known for its scenic beauty. Since ancient times, the Seto Inland Sea has served as a transportation route, bringing about cultural and industrial development. However, high population density and industrial development led to an increase in wastewater, causing the Seto Inland Sea environment to deteriorate to the extent that, by the 1970's, the sea appeared to be dying. Alarmed by worsening environmental conditions, concerned governors and mayors established in 1971 the Governors' and Mayors' Conference on the Environmental Protection of the Seto Inland Sea. In 1978, this conference took a leading role in enacting the Extraordinary Law Concerning Special Measures for the Conservation of the Environment of the Seto Inland Sea. At the same time, the prefectures and cities jointly financed and established the Seto Inland Sea Environmental Association, to disseminate knowledge relating to environmental conservation in the Seto Inland Sea. This association has been actively involved in environmental conservation in compliance with this conservation objective. (Author's abstract)
W91-10573

INTERNATIONAL PROGRAMME FOR THE PROTECTION OF A SEMI-ENCLOSED SEA: THE MEDITERRANEAN ACTION PLAN.

United Nations Environment Programme, Athens (Greece). Co-ordinating Unit for the Mediterranean Action Plan.

A. Manos.
Marine Pollution Bulletin MPNBAZ, Vol. 23, p
489-496, 1991. 1 ref, 4 append.

Descriptors: \*Coastal waters, \*Environmental monitoring, \*International agreements, \*Mediterranean Sea, \*Water pollution control, Air pollution control, Ballast water, Desertification, Endangered species, Human population, Legal aspects, Marine pollution, Outfall, Population density, Regulations, Waterwater treatment facilities, Water pollution

The United Nations Conference on the Human Environment included the protection of the oceans against pollution among the priorities for international action. The Mediterranean Action Plan was launched under the auspices of the United Nations Environmental Programme, coordinating the efforts of eighteen coastal states and the European Economic Community. The Action Plan has four components: socio-economic, aimed at identifying the causes of pollution and the methods readily available for pollution reduction; scientific, aimed at collecting valid, comparable data on priority pollutants, as a basis for legal and other measures; legal, that would commit coastal states to an active program, going beyond mere declarations; and institutional, to ensure the continuity of action with funds earmarked. Also included are the specific quality criteria, emission standards and other measures already adopted by the Mediterranean States. Ten targets have been specifically set, including the establishment of reception facilities for dirty ballast water and other oil residues received from tankers and ships in ports of the Mediterranean; establishment of sewage treatment plants in all cities around the Mediterranean with more than 10,000 inhabitants; applying environmental impact assessment to ensure proper development activities; cooperation to improve the safety of maritime navigation and to reduce the risk of transport of toxic substances likely to affect the coastal area or to induce marine pollution; protection of endan-

### Group 5G-Water Quality Control

gered marine species; reduction in industrial pollution and disposal of solid waste; preventing and combatting forest fires, soil loss, and desertifica-tion; and reducing air pollution which adversely affects coastal areas and the marine environment with the potential danger of acid rain. (Brunone-PTT) W91-10574

ENVIRONMENTAL RESEARCH, POLICY AND REGULATION: THE CHESAPEAKE BAY AND REGULATE EXPERIENCE.

Maryland Univ., Cambridge. Center for Environ-mental and Estuarine Studies. T. C. Malone, and W. H. Bell. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 497-501, 1991. 1 tab, 5 ref.

Descriptors: \*Chesapeake Bay, \*Coastal waters, \*Environmental impact, \*Environmental law, \*Environmental law, \*Environmental law, \*Environmental policy, \*Regulations, \*Water pollution prevention, Public policy.

Current efforts to manage the environmental impacts of human activities tend to focus on symptoms of environmental stress rather than on underlying causes. Given the need for immediate action, a distinction must be made between short-term, tactical responses to indicators of stress and long-term, strategic solutions based on a theoretically sound understanding of ecosystems and the role of the human species in ecosystems. The formulation of environmental policy and management plans for coastal seas must be based on information generated by environmental research that is independent ed by environmental research that is interpendent of government agencies responsible for policy and management and special interest groups that have environmental agendas. Chesapeake Bay is an ex-ample of the relevance of independent research to coastal seas governance and the importance of clearly defined roles and relationships among research institutions and government agencies. The Chesapeake Bay Program embodies two of the major ingredients required for a comprehensive coastal seas' governance initiative: the recognition that environmental management must reconcile the immediate need to respond to the symptoms of environmental stress with the ultimate requirement for a fundamental understanding of the effects of human activities; and a holistic view of environmental management based on the principle that a healthy environment and economic development are interdependent. (Brunone-PTT) W91-10575

NON-REGULATORY APPROACHES TO MAN-AGEMENT OF COASTAL RESOURCES AND DEVELOPMENT IN SAN FRANCISCO BAY. California State Coastal Conservancy, Oakland. For primary bibliographic entry see Field 2L. W91-10576

ENVIRONMENTAL MANAGEMENT OF THE PUGET SOUND.

Puget Sound Water Quality Authority, Seattle, WA. N. McKay. Marine Pollution Bulletin MPNBAZ, Vol. 23, p

509-512, 1991. 5 ref.

Descriptors: \*Environmental impact, \*Estuaries, Puget Sound, \*Water pollution control, \*Water quality control, \*Water resources management, Economic aspects, Legal aspects, Storm water, Wastewater pollution, Wetlands.

Puget Sound shows a characteristic estuarine circulation pattern. The Sound is showing symptoms of poor resources management, with multiple industrial and domestic sources contributing to the growing amount of waste entering the waters.
Through the establishment of the Puget Sound
Water Quality (PSWQ) Authority, the national Water Quality (PSWQ) Authority, the national setuary program has been implemented, designed to address comprehensively pollution from all sources and require all sources to share responsibility for improving water quality. The PSWQ Management Plan has thirteen programs: municipal and industrial discharges, contaminated sediments and dredging, oil spill prevention and response, storm-

water and combined sewer overflows, nonpoint water and combined sewer overflows, nonpoint source pollution control, shellfish protection, wet-lands protection, laboratory support, household hazardous waste, monitoring, research, education and public involvement, and legal and personnel support. Full implementation of this plan would cost about \$27 million/yr. (Brunone-PTT) W91-10577

SEA AND FRESH WATER CONSERVATION. Osaka Prefecture Water Works Bureau (Japan). K. Hattori, Y. Inoue, and T. Okumura. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 519-523, 1991. 6 fig, 4 ref.

Descriptors: \*Japan, \*Seawater, \*Water pollution control, \*Water quality control, \*Water quality standards, Ammonia, Biological oxygen demand, Human population, Land use, Mathematical models, Nutrient concentrations, Organic carbon, Osaka Bay, Precipitation, Seasonal variation, Wastewater pollution, Yodo River.

Sea water qualities are closely related to river water qualities. Therefore, prevention of fresh water pollution can be important in preventing sea water pollution. The Yodo River is the biggest river in the Kinki district, flowing into the Osaka river in the Kinki district, flowing into the Osaka Bay, and provides water for industries and domestic use, serving 10 million people. Recently the water has become polluted due to rapid economic growth. Ammonia concentrations have been gradually increasing, with large seasonal differences and an annual average concentration of 1.0 mg/L. BOD annual average concentrations are about 3.0 mg/L, with no sasonal fluctuations. The Yodo River basin was geographically divided into nine watersheds for a model equation describing pollution discharge into the river, involving papollution discharge into the river, involving parameters of land use, ratio of sewage to population, precipitation, etc. Annual total organic carbon was estimated at 30,000 tons, with Lake Biwa contributing 40% and Katsura River contributing 20%. Committees for pollution control include the Yodo River Water Consultative Committee and the Yodo River Water Protection Committee. These committees are urging the construction of sewage treatment plants for improvement of effluents from industries, and homes. Control of freshwater pollution should result in effective pollution control for seawater quality. (Brunone-PTT) W91-10578

CONTROLLING EFFECT OF THE PLANNED MANAGEMENT OF THE ENVIRONMENT IN THE KAGOSHIMA BAY ON THE POLLUT-ANT LOAD

Kagoshima Prefecture Environment Preservation Center (Japan). Dept. of Information Management.

K. Yamano. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 525-531, 1991. 5 fig, 1 tab

Descriptors: \*Coastal waters, \*Coastal zone management, \*Japan, \*Kagoshima Bay, \*Pollution load, \*Water pollution control, \*Water pollution sources, Animal wastes, Chemical oxygen demand, Domestic wastes, Fish farming, Industrial wastes, Phosphorus, Regulations, Wastewater pollution, Water quality standards.

Kagoshima Bay is formed by a caldera, having an average depth of 117 m. The bay area supports a population of 850,000. The COD levels in the bay have remained constant (around 1.6 mg/L in the center of the end of the bay, and 1.3 mg/L at the center of the middle of the bay, while the phosphorus levels have increased to 30 microg/L in recent years. The Project for Controlling the Water Quality and Environment of Kagoshima Bay was established to serve as a guideline for various pollution control activities. Targets set by the Project include allowable limits of 16.1 tons/day of pollutants discharged, at or below 2.0 mg/L day of pollutants discharged, at or below 2.0 mg/L COD, and 0.030 mg/L or below for phosphorus. During Phase I of the Project, general principles for measures against miscellaneous household wastewater were instituted, recycling of livestock waste on farms was encouraged, guidelines for the cultivation of fish in the prefecture were estab-lished, factory waste regulations became stricter, the public sewer system was constructed and extended, and pollution consciousness was enhanced. Even with these measures, pollution levels have increased in the Bay. (Brunone-PTT)

INTEGRATED MANAGEMENT OF THE BALTIC SEA.

National Swedish Environment Protection Board. R. Ferm.

arine Pollution Bulletin MPNBAZ, Vol. 23, p 533-540, 1991. 7 fig, 1 tab.

Descriptors: \*Baltic Sea, \*Bioaccumulation, \*Sediment contamination, \*Water pollution prevention, \*Water pollution sources, Aquatic habitats, Brackish water, Chlorinated hydrocarbons, Ecosystems, Eutrophication, Fish, Human diseases, Industrial wastewater, Nitrogen, North Sea, Nutrient concentrations, Organic carbon, Path of pollutants, Phosphorus, Pollution load, Pulp and paper industry, Sediment chemistry, Shellfish, Toxicity, Wastewater treatment facilities, Water quality.

The Baltic Sea is one of the largest brackish water areas in the world, with very slow water exchange between the Baltic and the North Sea. As a result, between the Baltic and the North Sea. As a result, the water in the Baltic has a very long residence time, on the order of 35 to 40 years, leading to accumulation in water, sediments and biota of discharged pollutants. Urban areas contribute approximately 25% of the land-based sources of nutrient inputs into the Baltic. Installation of biological treatment systems is expected to dominate the investments in municipal treatment systems around the Baltic Sea, to remove nutrients to reduce or prevent eutrophication. The pulp and paper processing industry in Sweden and Finland is responsible for the major part of the chlorinated organic compound pollution load in the Baltic, while fertilizer production has caused heavy discharges of phosphorus and nitrogen salts and cadmium. Eutrophication is the most pronounced problem in the Baltic, although the increasing concentrations of toxic organic substances constitute an ever greater threat to the environment in the long term. Overall goals for the area include the maintenance Overall goals for the area include the maintenance of vigorous, balanced populations of naturally occurring species; the achievement of natural zoning of flora and fauna; prevention of harmful anoxic conditions; continuation of regular fishing; consumption of fish and shellfish from the area without health risks; and ensuring that pollution does not restrict the recreational value of the area. Measures must be taken to limit the quantity of these nutrings entering the sea and organic manner. these nutrients entering the sea, and organic man-made pollutants must also be reduced. (Brunone-PTT) W91-10580

ENVIRONMENTAL INFORMATION PROC-ESSING OF CLOSED BAY AREA BY REMOTE SENSING.

Tokushima Univ. (Japan). Dept. of Information Science and Intelligent Systems. For primary bibliographic entry see Field 7B.

PERSONAL COMPUTER SYSTEM SUPPORTING WATER QUALITY MANAGEMENT IN EUTROPHICATED BAY.

EUTROPHICALED BOX.
Osaka Univ. (Japan).
T. Morioka, Y. Kido, A. Miichi, and M. Nakadan.
Marine Pollution Bulletin MPNBAZ, Vol. 23, p
557-561, 1991. 6 fig, 1 tab.

Descriptors: \*Coastal zone management, \*Computer programs, \*Eutrophication, \*Japan, \*Marine pollution, \*Mathematical models, \*Red tide, \*Water pollution control, \*Water quality monitoring, Chemical oxygen demand, Correlation analysis, Nutrient concentrations, Organic matter, Osaka Bay, Phosphorus, Pollution load, Spatial distribution, Tidal movement.

A red tide frequently occurs in Osaka Bay in the summer season, even though construction of a sewer system and regulation of point source pollu-

Water Quality Control—Group 5G

tion has taken place. Organic pollutant and nutrient loads transported from the interior of Osaka Bay by tidal movement causes the eutrophication bay by tidal movement causes the eutrophication in the wide area of the bay. A personal computer-based system has been developed to support policy-makers in the formulation of water quality management plans. The computer system consists of four subsystems furnished by a water quality model and an external loading model. The water quality model uses non-conservative balancing of the strength of t quanty model uses non-conservative balancing of chemical oxygen demand to meet environmental standards; and uses organic phosphorus, and inor-ganic phosphorus levels to assess eutrophication in Osaka Bay. Correlation analysis was used to group local input waters into clusters. Model limitations include: (1) inorganic phosphorus concentration values are lower in the summer than measured; (2) values are lower in the summer than measure, (c) tidal movement is dominant over diffusion in the determination of spatial distribution of pollutants in the model; and (3) the mean concentration values of the model cannot be directly compared with the observed values, because monitoring points are unevenly distributed. The computer graphics pro-vide visual information for decision-making. The system enables policy-makers to effectively solve the complex problem of technological and administrative problems, such as wide-area eutrophication control in enclosed seas. (Brunone-PTT) W91-10582

MANAGEMENT OF THE MARINE ENVIRON-MENT IN WESTERN AUSTRALIA: AN ECO-SYSTEM APPROACH. Western Australia Ministry for the Environment,

Perth.

R. J. Pearce.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p

Descriptors: \*Australia, \*Coastal areas, \*Coastal zone management, \*Domestic wastes, \*Industrial wastes, \*Water pollution control, Assimilative capacity, Drainage systems, Environmental effects, Nutrient concentrations, Pollution load, Wastewater pollution.

The Environmental Protection Authority of Western Australia (EPAWA) has the responsibility for controlling industrial and domestic waste inputs to state waters. With continued industrial developcontrolling industrial and domestic waste injuis to state waters. With continued industrial development and urban expansion to the north and south of Perth, pollutant loadings to nearshore marine environments will inevitably rise as a result of increases in industrial and domestic waste discharge, urban drainage and groundwater inflow. These increased loadings will cause additional stresses on the nearshore marine ecosystems of Perth. The EPAWA has adopted the concept of assimilative capacity as a philosophical approach to maintain the biological integrity of nearshore coastal ecosystems in Western Australia. This approach is based on the assumption that the receiving environment has some capacity, albeit limited, to disperse, dilute and absorb certain types of pollutants without incurring long-term damage to the biological functioning of the marine communities in question. Cockburn Sound, a marine embayment adjacent to the southern metropolitan waters of in question. Cockburn Sound, a marine embayment adjacent to the southern metropolitan waters of Perth, is an example of how this approach can be used to restore formerly severely polluted waters. The EPAWA's approach to controlling nutrient enrichment of the nearshore waters of the Perth region (which includes the Marmion Marine Park) can demonstrate how the principle of the 'assimilative capacity' approach is being utilized to prevent deterioration of 'pristine' ecosystem. (Author's abstract) stract) W91-10583

CONCEPTUAL FRAMEWORK OF ENVIRON-MENTAL MANAGEMENT STRATEGIES FOR YUGOSLAVIA: THE CASE OF THE ADRIATIC

Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research.

V. Pravdic.
Marine Pollution Bulletin MPNBAZ, Vol. 23, p

Descriptors: \*Adriatic Sea, \*Coastal zone management, \*Environmental impact, \*Environmental

monitoring, \*Yugoslavia, Economic aspects, Economic development, Enclosed seas, Future planning, Legal aspects, Regional development, Regulations, Resource allocation.

The Adriatic is a narrow, semi-enclosed basin of the Mediterranean Sea, stretching deeply into the central part of the European continent. Developmental pressures are particularly sensitive in all semi-enclosed seas, and the case of the Adriatic Sea is no exception. The conceptual basis of an environmental management blueprint rests on the principle of integrated socio-economic, technological and physical planning with the environmental capacity concept as an environmental protection capacity concept as an environmental protection regulatory measure. The European continent has experienced three phases of strategies of environexperienced three phases of strategies of environ-mental management and protection: various laws and regulations relying on restrictions, prohibi-tions, and penalties for violation (polluter-pays-principle); the first phase combined with economic incentives to encourage pollution prevention and control; and comprehensive environmental man-agement, based on anticipatory measures and on allocation of resources. The implementation of new ideas in marine environmental management applied to semi-enclosed seas such as the Adriatic new ideas in marine environmental management applied to semi-enclosed seas such as the Adriatic will become possible with an effort in strategic planning of future development. The drafting of a long-term plan in Yugoslavia can be considered a test as to whether the conceptual framework of comprehensive environmental, economic, social and technological development can be harmonized into a viable strategy for a semi-enclosed sea. (Brunone-PTT)

ENVIRONMENTAL ACTIVISM IN THE SAN FRANCISCO BAY ESTUARY.

San Francisco Estuary Project, P.O. Box 2050, Oakland, California.

M. W. Monroe.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 607-611, 1991. 23 ref.

Descriptors: \*Conservation, \*Environmental moni-Descriptors: "Conservation, 'Environmental moni-toring, "Estuaries, "Public participation, "San Francisco Bay, "Water resources management, Agriculture, Cooperation, Drinking water, Human population, Industrial development, Oil spills, Tourism.

Within the San Francisco Bay Estuary (SFBE) basin is a large urban population that is relatively sophisticated in its concern about environmental sophisticated in its concern about environmental groups are working to protect and enhance the Estuary and its resources, and they articulate public concerns regarding the Estuary and influence the formulation and implementation of government policies and programs. The SFBE is the most modified again, server in the lighted States emphasized for cies and programs. The STDE is the most modified major estuary in the United States, supplying 40% of the State's drinking water, as well as water for agriculture and industry, and supports commercial and sport fisheries. Respondents to a questionnaire mailed to resource managers, elected officials, scientists and public interest groups indicated that the four most important environmental problems are four most important environmental problems are wetlands filling, habitat loss, toxins, and freshwater diversion. Some of the more recent projects include the development of Cullinan Ranch, Harbor Bay Isle, the control of the Shell Oil Spill, Unocal, and dredging in San Francisco Bay. Through individual efforts and in coalitions, the environmental groups are successful largely because they represent the sentiments of a large portion of the public, and because they are able to form cooperative working relationships with a variety of interests. If recent trends continue, the environmental community's influence on the attitudes and actions of the public, lawmakers, and regulators will strengthen public, lawmakers, and regulators will strengthen the Estuary's protection. (Brunone-PTT) W91-10885

PARQUE DE DONANA', AND ITS CONTRIBUTION TO ENVIRONMENTAL ACTIVITIES FOR ENVIRONMENTAL PROTECTION. Fundacion Jose Maria Blanc, Fortuny No. 27, 28010 Madrid, Spain.

J. M. B. Diaz. Marine Pollution Bulletin MPNBAZ, Vol. 23, p

617-619, 1991.

Descriptors: \*Coastal zone management, \*Environmental impact, \*Irrigation projects, \*Marshes, \*Spain, Agriculture, Drainage systems, Economic aspects, Guadalquivir River, Land restoration.

The river Guadalquivir's marshes are located at the river mouth, between the Atlantic Ocean and the river's right bank. Since 1969, the National Park of Donana, Spain, has been located in the heart of this area. The Park has an area of 50,720 hectares, 25,000 of which are flooded in the wet season. Around 1925, the purchasing and specula-tion of land on the banks of the river began with the drainage of the land and the establishment of irrigation systems to produce cotton and rice. In 1930, the first major efforts to drain the marshes were accomplished to allow for colonist settle-ment. In 1971, the State declared as a matter of National Interest the transformation of 45,950 hec-National Interest the transformation of 45,950 hec-tares neighboring the Park into an irrigation area. A year later, when the works were completed, the area was reduced to 10,000 hectares, because the desiccation of the subterranean water contributed to the drainage of the flooded areas of the Park. The Jose Marie Blanc Foundation, a non-govern-mental organization, owns important extensions of land within the premises of the Natural Park, and will play an important conservationist role through careful management of their land. The Jose Maria careful management of their land. The Jose Maria Blanc Foundation, in cooperation with the General Direction for the Environment of the European Community, and with financial support, is carrying out the protection and conditioning of a shelter in the marshes of the river, especially designed to protect and preserve three endangered species in a area of over 200 hectares. (Brunone-PTT)

CITIZEN'S MOVEMENTS TO PROTECT THE ENVIRONMENT OF RIVERS FLOWING INTO THE SETO INLAND SEA: AN EXAMPLE OF A CITIZEN'S MOVEMENT ALONG THE TOGA RIVER.

The Group to Protect the Toga River, 4-12, Shi-kanoshita-dori, 1 chome, Nada-ku, Kobe, 658

Y. Hashimoto. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 621-622, 1991.

Descriptors: \*Coastal zone management, \*Japan, \*Public participation, \*Rivers, \*Seto Inland Sea, \*Toga River, Aesthetics, Education, Water quality

Toga River flows through a densely urbanized area of the city of Kobe before emptying into the Port of Kobe in the Seto Inland Sea. The river has Port of Kobe in the Seto Inland Sea. The river has flooded many times during heavy rains in the past and present, and the river bed and the embankment are covered with concrete. People living along the river formed the Group to Protect the Toga River in 1977, with the aim of protecting the river in their neighborhood and restoring it to a more aesthetic river through their own efforts. The group has held waterside classrooms, aimed mainly at children, cleaned up the river, and communicate with similar groups in order to exchange and ed with similar groups in order to exchange and put into practice new activities aimed at preserving water quality. (Brunone-PTT) W91-10587

NONGOVERNMENTAL EDUCATIONAL ACTIVITIES FOR ENVIRONMENTAL PROTECTION.

Hiroshima Community Health Service Association (Japan). Div. of Education.

N. Komoda. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 627-632, 1991. 3 fig, 2 tab.

Descriptors: \*Environmental monitoring, \*Environmental policy, \*Public participation, \*Water pollution control, Domestic wastes, Education, Environmental effects, Industrial wastes, Training.

Although industrial drainage is regulated by law in Japan, no regulations exist for domestic drainage.

### **Group 5G-Water Quality Control**

Waterside classes were held as a part of environmental education. Conditions necessary to promote waterside classes in a community are the establishment of a methodology, the training of leaders, and the preparation of teaching materials. Between 1984 and 1989, 66 classes were held with the participation of 3494 local community members. Trained leaders are indispensable to develop the movement to protect the water environment, and at the same time, networks have to be formed for movement to protect the water environment, and at the same time, networks have to be formed for the leaders. Functional leaders are taught the methods of biological examination of aquatic life and practical methods to improve the water environment at the home level. Through this community organization, the citizens gain a better understanding of the threat to the environment caused by domestic drainage. Grunone, PTT. by domestic drainage. (Brunone-PTT) W91-10588

NATIONAL ESTUARY PROGRAM AND PUBLIC INVOLVEMENT.

Environmental Protection Agency, Washington, DC. Office of Marine and Estuarine Protection.

M. A. Hiller.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p

Descriptors: \*Coastal zone management, \*Envi-ronmental protection, \*Estuaries, \*Public partici-pation, \*Water pollution control, Environmental monitoring, Future planning, National Estuary Program, Water quality monitoring, Water quality

The U.S. Environmental Protection Agency is using collaborative problem solving and consen problems in the building to address environmental problems in the nation's estuaries. The National Estuary Program establishes management conferences to develop and implement a comprehensive conservation and ement plan for estuaries of national significance. Representatives of federal, state, and local governme governments, the academic and scientific commu-nities, and the public and private sectors are asked to agree on the most important problems and the corrective action needed. The comprehensive plan recommends priority corrective actions and com-pliance schedules addressing point and nonpoint sources of pollution to restore and maintain the chemical, physical and biological integrity of the estuary. An important component of public in-volvement in the National Estuary Program is citizens' volunteer monitoring. Volunteer monitor-ing data is collected and used to meet a number of different water quality management objectives. Ennts, the academic and scientific commuing data is collected and used to meet a number of different water quality management objectives. Enforcement and compliance monitoring programs require quality assured and quality controlled data. Citizen monitoring provides data to meet these objectives, plays a key role in building public support for action, and ultimately creates the will to accomplish water quality improvement and other environmental goals. Citizen volunteers can augment monitoring programs already in existence at federal, state, and local levels. Mobilization of citizen volunteers permits the collection of data that would not be available through conventional methods. (Author's abstract) W91-10590

REGIONAL-WIDE WASTE DISPOSAL PROJECT ON SEACOAST OF ENCLOSED COASTAL SEA.

Osaka Bay Center for Regional Offshore Land Reclamation, Bingo-machi 4-1-3, Chuoku, Osaka,

imary bibliographic entry see Field 5E. For primar W91-10594

WATER QUALITY PURIFICATION SYSTEM

FOR THE ENCLOSED SEA AREA.
Osaka Prefecture Engineering Office, 210, Ogura,
Wakayama, 649-62 Japan.
K. Akai, S. Ueda, Y. Wada, and R. Tuda.
Marine Pollution Bulletin MPNBAZ, Vol. 23, p 683-685, 1991. 7 fig.

Descriptors: \*Breakwaters, \*Japan, \*Marine pollu-tion, \*Water pollution control, Aeration, Econom-ic aspects, Nitrogen, Nutrient concentrations, Osaka Bay, Oxidation, Phosphorus, Red tide, Sedi-

mentation, Suspended sediments, Tidal range, Tides, Transparency, Water treatment, Wave

Polluted sea water can be purified by a rubble mound breakwater. The sea water which sur-rounds the breakwater undergoes sea wave aer-ation and contact oxidation. The breakwater acts ation and contact oxidation. The breakwater acts as a sedimentation pond or oxidation lagoon. The volume of purified sea water is dependent on sea water area and tidal range difference. Generally 200,000,000 cubic m purified water is produced each day. When tested in an experimental hollow in Osaka Bay, in July, the purification system improved transparency from 60 to 170 cm, turbidity from 0.56 to 0.2 mg/L, suspended sediments from 6.06 to 4.6 mg/L, and COD from 4.64 to 3.73 mg/L. Under red tide conditions, the breakwater diluted the water, decreasing nitrogen and phosphorus, and reducing red tide. The breakwater, after initial installation, requires little additional cost, because energy is drawn from the waves and tidal ebb and flow. (Brunone-PTT) W91-10596

TREATMENT AND DISPOSAL STRATEGIES IN GREECE.

Ministry of Physical Planning, Housing and Environment, Athens (Greece).

J. A. Leontaritis.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 691-693, 1991.

Descriptors: \*Greece, \*Mediterranean Sea, \*Path of pollutants, \*Wastewater disposal, \*Wastewater treatment, \*Water pollution control, \*Water polluti tion sources, Amvrakikos Gulf, Future planning, Human population, Maps, Marine pollution, Mu-nicipal wastes, Pagassitilos Gulf, Population dy-namics, Saronoicos Gulf, Thermaikos Gulf, Urban

Greece lies on the northeastern shore of the Mediterranean Sea, a closed sea with a low water exchange rate. The length and shape of the coasts, the geographic distribution of the population and economic activities, as well as the terrain relief, create many problems with coastal and marine pollution. Saronoicos Gulf and Thermaikos Gulf pollution. Saronicos Guit and Thermakos Guit receive urban runoff and domestic sewage, Pagassitilos Gulf receives municipal sewage and agricultural pollution, and Amvrakikos Gulf receives multiple domestic and industrial waste. To determine the optimal restoration plan, studies of each area were carried out, with problems listed and soluwere carried only, with proteins instea and soft-tions proposed. The physical environment was de-scribed and the local economic structure defined. Existing water supply and sewer systems were mapped. Population trends were estimated, as well as existing and future pollution loads. Based on the collected data, a preliminary prediction of the col-lection, transport, treatment and disposal works. lection, transport, treatment and disposal works was made. The impact of the sewage disposal was investigated for sea disposal. The construction cost of treatment and disposal works depends on the degree of the treatment, the population served, and the local conditions. (Brunone-PTT) W91-10598

MEASURES FOR PURIFICATION OF THE LEACHATE FROM 'RENSEANLAEG DAMHU-SAEN' INTO COPENHAGEN WATERS, TO

MEET THE NPO-PLAN.
Danmarks Ingenioerakademi, Lyngby. Kemiafde-

For primary bibliographic entry see Field 5D. W91-10601

FLOW CONTROL TECHNOLOGY FOR EN-HANCEMENT AND DIVERSE USE OF THE MARINE ENVIRONMENT.

Government Industrial Research Inst., Chugoku, For primary bibliographic entry see Field 2L. W91-10607

IMPROVED POLICY INSTRUMENTS FOR MANAGEMENT OF ENCLOSED COASTAL SEAS AND ESTUARIES: THE CHESAPEAKE

Maryland Univ., Solomons. Center for Environ-mental and Estuarine Studies. For primary bibliographic entry see Field 2L. W91-10610

LEGAL SYSTEM AND MANAGEMENT OF SOUTHERN FRANCE LAGOONS.

Toulouse-1 Univ. (France). W. Coulet.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 793-795, 1991.

Descriptors: \*Coastal zone management, \*Envi-ronmental protection, \*France, \*Lagoons, \*Public policy, \*Regulations, \*Water pollution control, Agriculture, Channels, Economic development, Industrial wastes, Land use, Mariculture, Non-structural alternatives, Research, Sandbars, Sanita-tion, Tourism, Wastewater discharge, Wastewater pollution, Water pollution sources.

Along the southern coast of France are located pproximately fifteen lagoons, separated from the channels, These lagoons are natural zones allowing economic, recreational and tourist activities. Pollueconomic, recreational and tourist activities. Pollu-tion in these areas originates from industrial dis-charge, agricultural runoff from vineyards, shell-fish farming, and lower sanitation with increased tourist traffic. Water regulations about building limits and environmental standards require pollu-tion control on both a national and a municipal basis. Funding has been provided to fight pollution increases. Public and private initiatives have com-bined economic development and environmental protection. Improvements of the sanitation system around the lagoons have been implemented. A national reserve was erected in 1975 to preserve national reserve was effected in 1973 to preserve the environment and to develop scientific research projects on an area of 32,500 acres of protected and. The natural regional park of Camargue was created on 200,000 acres of lagoon area. (Brunone-PTT) W91-10611

HEALTH-RELATED WATER MICROBIOLO-GY 1990.

For primary bibliographic entry see Field 5F. W91-10612

USE OF RISK ASSESSMENT FOR DEVELOP-MENT OF MICROBIAL STANDARDS.

University of South Florida, Tampa. Dept. of Environmental and Occupational Health. J. B. Rose, and C. P. Gerba.

Water Science and Technology WSTED4, Vol. 24, No. 2, p 29-34, 1991. 4 tab, 8 ref.

Descriptors: "Microorganisms, "Pathogens, "Protozoa, "Public health, "Risk assessment, "Viruses, "Water quality standards, "Water treatment, Doseresponse relationships, Giardia, Microbiological studies, Model studies, Potable water, Water qual-

A single-hit exponential model and a beta-distributed 'infectivity probability' model were used to evaluate the potential health risks from drinking water containing low levels of protozoan cysts and viruses, respectively. The models were based on dose-response curves developed from human feeding studies and assumed consumption of 2 L/day. The U. S. Environmental Protection Agency has accounted that one infection/10 000/vers is an accounted that the infection/10 000/vers is an accounted that the counter of the c A single-hit exponential model and a beta-distributsuggested that one infection/10,000/year is an acceptable risk for infectious agents acquired through potable water. Based on this risk, acceptable levels of viruses and cysts were determined using the probability models. Thus poliovirus and rotavirus levels should not be more than 0.1 and 0.3 pfu/ 100L respectively per day. Giardia levels should be below 0.2 cysts/100L. To achieve an annual risk of 1:10,000, the geometric average should not exceed 0.001 organisms/100L. As monitoring treated water for these levels would be difficult, source waters may be monitored. Geometric average of 1000 organisms/100L respired 1000L respired 100 ages of 1-100 organisms/100L require 3-5 logs of treatment reduction to achieve the 1:10,000 risk. The risk models for viruses and protozoa can be used to evaluate the occurrence of pathogens in

source water and determine the appropriate treatment needed to obtain specific levels of safety for drinking water. (See also W91-10612) (Author's abstract) W91-10619

PUBLIC HEALTH CRITERIA FOR THE AQUATIC ENVIRONMENT: RECENT WHO GUIDELINES AND THEIR APPLICATION.

World Health Organization, Geneva (Switzer-land). Div. of Environmental Health. R. Helmer, I. Hespanhol, and L. J. Saliba. Water Science and Technology WSTED4, Vol. 24, No. 2, p 35-42, 1991. 1 fig, 4 tab, 16 ref.

Descriptors: \*Epidemiology, \*International com Descriptors: \*Epidemiology, \*International com-missions, \*Path of pollutants, \*Public health, \*Water pollution sources, \*Water quality stand-ards, \*Water treatment, Bioindicators, Coastal waters, Coliforms, Developing countries, Drinking water, Feces, Helminths, Mediterranean, Patho-gens, Regulations, Risk assessment, Rural area-shellfish, Swimming, Viruses, Water quality moni-toring.

Over the past decade, the World Health Organiza-tion has developed a series of microbiological guidelines covering different aspects of the aquatic environment. Transmission pathways of human pathogens from their fecal origin back to man via drinking water, bathing waters, shellfish, and sewage-treated crops were investigated and epide-miology-based health criteria established. The total and fecal coliform guideline values for drinking water are generally complied with in urban water supplies but are difficult to meet in rural areas of developing countries. The Mediterranean serves as the major study area for assessing health risks from bathing in coastal waters and from the consump-tion of shellfish eaten uncooked. Wastewater reuse tion of shellfish eaten uncooked. Wastewater reuse for crop irrigation is rapidly expanding due to water shortages but poses health risks to farm workers and consumers. New guidelines for control of helminths were recently issued by a WHO Scientific Group. The predominant agent of concern varies widely among transmission pathways. Viruses are of prime importance in drinking water because of diarrhea, but they are of least concern for wastewater reuse where helminths are of for wastewater reuse, where helminths are of prime concern. Closely linked to the pathogen of concern is the choice of indicator organisms for monitoring and control. It is concluded that, especially in the control of the control o cially in developing countries, the prescription of effective treatment methods may prevent pathogen transmission more effectively than the often unreliable effectives. able enforcement of regulatory standards. (See also W91-10612) (Doria-PTT) W91-10620

EC BATHING WATER VIROLOGICAL STANDARD: IS IT REALISTIC.

Severn-Trent Labs., Coventry (England) For primary bibliographic entry see Field 5A. W91-10622

PRODUCTION AND CONTROL OF REFERENCE MATERIALS FOR WATER MICROBI-OLOGY.

Rijksinstituut voor de Volksgezondheid en Milieu-hygiene, Bilthoven (Netherlands). Lab. for Water and Food Microbiology. For primary bibliographic entry see Field 5A. W91-10623

PRELIMINARY STATISTICAL ASSESSMENT OF UK WATER QUALITY CONTROL TRIALS. Central Public Health Lab., London (England). Communicable Disease Surveillance Centre. H. E. Tillett, and N. F. Lightfoot. Water Science and Technology WSTED4, Vol. 24, No. 2, p 57-60, 1991. 1 fig, 1 tab, 2 ref.

Descriptors: \*Interlaboratory comparison, \*Quality control, \*Statistical analysis, \*United Kingdom, \*Water analysis, \*Water pollution control, Bacterial analysis, Data quality control, Laboratory methods, Public health, Statistical

The Public Health Laboratory Service has been distributing simulated water samples for quality control of bacterial analysis in the United King-dom since 1986. To assess whether a laboratory is a 'poor performer' it is necessary to observe results a poor performer it is necessary to observe results from a series of samples and see whether they report 'tail-end' results more often than would be expected by chance. The statistical assessment is made using the nonparametric method of Cochran's Q test, which looks at the scatter of binary (+/-) data in a two-way table and searches for ran's Q test, which looks at the scatter of binary (+/-) data in a two-way table and searches for nonrandomness. This test avoids any need to assume that the results are Normal, log-Normal, or Poisson. The null hypothesis that low 'tail-end' counts are occurring at random throughout the participating laboratories can be tested; the same procedure can be done with high 'tail-end' counts. A laboratory is said to have succeeded (+) with a particular sample if its count is greater than or equal to the 'tail-end' cutoff point, and is said to have failed (-) if it is less than that value. Participants are sent a copy of the assessment, highlighting their position. If the Q statistic is significant, then it should be pointed out that 'poor performance' has been demonstrated. The test is applicable only to laboratories that have returned the results for the full series of specimens. A laboratory that fails to send in results because they did not seem satisfactory has in fact passed judgment on itself. (See also W91-10612) (Doria-PTT)

SURVEILLANCE SOLUTIONS TO MICROBIO-LOGICAL PROBLEMS IN WATER QUALITY CONTROL IN DEVELOPING COUNTRIES.

B. J. Lloyd, and J. K. Bartram. Water Science and Technology WSTED4, Vol. 24, No. 2, p 61-75, 1991. 6 fig, 5 tab, 8 ref.

Descriptors: \*Bacterial analysis, \*Chemical analysis, \*Developing countries, \*Microorganisms, \*Public health, \*Quality assurance, \*Water analysis, \*Water pollution control, \*Water quality monitoring, Indonesia, Inspection, Peru, Risk assessment, Surveys, Thailand, Tracers, Water pollution sources, Water treatment.

Many developing countries are failing to apply standard water quality control methods. To achieve necessary improvements, the limitations in conventional microbiological and chemical quality control must be recognized. In the search for simpler and cheaper methods, inaccurate and spurious results are being reported in at least 10 countries in results are being reported in at least 10 countries in the Southeast Asian and Pacific regions. An integrated surveillance strategy for progressive im-provement is suggested, consisting of the following steps: area selection and basic inventories; timetabling of inspection visits; diagnostic sanitary surveys; bacteriological and chemical analysis; identi-fication of potential sources of pollution; confirma-tion that contamination is occurring; special tracer tion that contamination is occurring; special tracer studies; identification of pollution sources; consoli-dation and classification of results of diagnostic surveys; formulation of prioritized remedial action strategy; establishment of routine monitoring pro-gram; and implementation of routine monitoring gram; and implementation of routine monitoring and risk assessment program. The basic methodol-ogy and philosophy of this program have been implemented successfully in pilot projects in Peru, Indonesia, and Thailand. However, there are inad-equacies in the system, including the applications. equacies in the system, including the equal weighting of different points of risk, as well as the bacteriological grading and sanitary inspection procedures. (See also W91-10612) (Doria-PTT) W91-10625

SUPERFUND RECORD OF DECISION: COM-

SUPERFUND RECORD OF DECISION: COM-MENCEMENT BAY/S. TACOMA, WA. Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-206395. Price codes: A66 in paper copy, A01 in microfiche. Report No. EPA/ROD/R10-88/016, March 1988. 71p, 11 fig, 8 tab, 4 append.

Descriptors: \*Cleanup operations, \*Commencement Bay/Tacoma Site, \*Groundwater pollution, \*Site remediation, \*Superfund, \*Washington, Benzenes, Costs, Monitoring, Toluene, Volatile organic compounds, Xylenes.

### Water Quality Control—Group 5G

The Commencement Bay/Tacoma site is a 190 acre industrial/municipal landfill located in Pierce County, Tacoma, Washington. The landfill is operated by the City of Tacoma Refuse Utility and is surrounded primarily by residential development and open land, with some commercial and industrial development. An aquifer beneath the site provides drinking water to the Town of Fircrest and the City of Tacoma, both of which have wells near the landfill. The Tacoma landfill began operations in 1960, to date, about 4 million tons of refuse have been deposited at the landfill to depths of 20-80 ft. Although the landfill does not accept hazardous wastes for disposal, it did receive wastes in the 1960s and 1970s that have since been designated as hazardous substances. Investigations have indicathazed to the statement of the substances. Investigations have indicathazed to the substances. Investigations have indicathazed to the substances. The Commencement Bay/Tacoma site is a 190 1908 and 1970s that have since ocen designated as hazardous substances. Investigations have indicated that the groundwater is contaminated with volatile organic compounds (VOCs). A field survey was initiated to evaluate the extent of off-site gas migration, and based on this survey a gas site gas migration, and based on this survey a gas extraction system was constructed to extract, collect, and combust the gas. Gas samples collected at the landfill revealed high levels of VOCs. The primary contaminants affecting the groundwater and surface water are VOCs including benzene, toluene, and sylenes. The selected remedial action for this site includes: construction of a cap on the landfill with runoff directed to appropriate storm or sanitary sewers, and installation of a gas extracor sanitary sewers, and installation of a gas extrac-tion system and gas probes to monitor methane gas production; installation of a groundwater pump and treatment system with discharge of treated water to a local creek or the publicly owned treatment works and alternate water supply if needed; and groundwater and surface water mo toring. The estimated present worth cost for this remedial action is between \$21,015,000 and \$23,418,000. (Author's abstract) W91-10711

TREATABILITY OF HAZARDOUS CHEMICALS IN SOILS: VOLATILE AND SEMIVOLATILE ORGANICS.

Oak Ridge National Lab., TN. Environmental Sciences Div.

For primary bibliographic entry see Field 5B.

W91-10712

SUPERFUND RECORD OF DECISION: CHEM-TRONICS (AMENDMENT), NC.

TRONICS (AMENDMENT), NC. Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-114646. Price codes: A05 in paper copy, A01 in microfiche. Report No. EPA/ROD/R04-89/049, April 1989. 71p, 6 fig, 4 tab, 7 append.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Hazardous wastes, \*North Carolina, \*Superfund, \*Water pollution sources, Costs, Explosives, Monitoring, On-site waste disposal, Organic compounds, Path of pollutants, Solvents, Waste capping, Water treatment.

This Record of Decision (ROD) amends the April 5, 1988, Chemtronics ROD which included an incorrect calculation regarding the chemical quality of the groundwater. The Chemtronics site is an active waste disposal facility located in a rural area of Swannanoa, North Carolina. Approximately 10 acres of the site were used for waste disposal facility in the control of the site were used for waste disposal facility in the control of the site were used for waste disposal facility. operations. Records indicate the presence of 23 individual on-site disposal areas (DAs) which are grouped into six discrete areas. Waste materials grouped into six discrete areas. Waste materials and solvents generated in the production of the chemical warfare agent 3-quinuclidinyl benzilate (BZ) and the tear gas agent o-chlorobenzylidene malonitrile (CS), were placed in 55 gallon drums with a neutralizing solutions, and then buried onsite in trench-type landfills. From 1971 to 1979, pits and trenchs were constructed, as needed, for the disposal of solids wastes, rocket motors, explosive wastes, spent acid, and various organic wastes. In 1980, the State ordered Chemtronics to discontin all on-site discharges, and the pits were subsequently backfilled. In September 1984, two drums were sampled because they were suspected of containing wastes from the production of BZ. Although no BZ was found, EPA initiated ann imme-

### Group 5G-Water Quality Control

diate removal of these drums in January 1985 due to heightened public awareness of the site. The original remedy (soil fixation-stabilization-soildification, capping) was selected due to the concentration levels of the contaminant benzylic acid a benzophenone found in the groundwater downgradient of one disposal site. However, a transcription error was discovered in the analytical results for this groundwater sample. The laboratory reported the concentration as 470 mg/L instead of 470 microgm/L. Subsequent sampling verified that the correct concentration was in the 0-470 microgm/L range. Therefore, EPA elected to change the source control remedial action for the site to capping only. The primary contaminants of concern affecting the soil, sediment, groundwater and surface water are volatile organic compounds including benzene, toluene, pesticides, and explosives. The selected remedial action for this site includes multi-layer capping; groundwater pumping and treatment using air stripping, carbon adsorption; and monitoring. (Lantz-PTT) W91-10713.

### SUPERFUND RECORD OF DECISION: IBM (SAN JOSE), CA.

(SAN JOSE), CA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-108481. Price codes: A07 in paper copy, A01 in microfiche. Report No. EPA/ROD/R09-89/029, December 1988. 145p, 7 fig, 4 tab.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*IBM (San Jose) Site, \*Path of pollutants, \*Superfund, \*Water pollution sources, Acctone, Aquifers, California, Drinking water, Groundwater movement, Organic compounds, Soil contamination, Solvents, Toluene, Trichloroethane, Volatile organic compounds, Waste storage, Water treatment, Xylenes.

International Business Machines (IBM) has owned and operated a facility in San Jose, California, since December 1956 using organic chemicals including trichloroethane (TCA), acetone, xylene, and petroleum naphthas. The organics have been handled and stored on-site in drums, and aboveground and underground tanks. In addition, waste organic solvents were stored in concrete or steel underground tanks or drums; however, the concrete tanks were designed only to store organic wastes. In October 1980, while excavating tanks in Tank Farm No. 1, IBM discovered soil contaminated with organics. Furthermore, investigations in November 1981 revealed extensive groundwater contamination. The groundwater plume extends more than 3 mi northwest and is more than 180 ft in depth. Fourteen active or potentially active water supply wells are downgradient to the plume; however none of these public wells have been found to contain volatile organic compounds (VOCs) above State and Federal drinking water standards. Nineteen sources of soil and groundwater contamination have been identified including and tank and pipeline fitting failures. Activities to prevent further solvent migration from the IBM source areas have been conducted including removing underground storage tanks which were replaced with above-ground tanks, and excavating more than 23,000 cu yd of contaminated soil. Interim remedial measures begun in November 1982 to clean up the plume have included off-site and onsite groundwater extraction with discharge of untreated groundwater to storm drains. The primary contaminants of concern affecting the soil and groundwater are VOCs including TCA, toluene, and xylenes; and other organics. The selected remedial action for this site includes on-site soil vapor extraction on-site sproundwater extraction with discharge of untreated groundwater to storm drains. The primary contaminants of concern affecting the soil and groundwater and off-site discharge to surface water after the reuse capacity of the aquifer is exhausted. Remedial acti

USING OIL SPILL DISPERSANTS ON THE

National Research Council, Washington, DC. Commission on Engineering and Technical Systems.

Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-198899. Price codes: A16 in paper copy, A01 in microfiche. National Academy Press, Washington DC. 1989. 335p, 28 fig, 32 tab, 690 ref, 3 append.

Descriptors: \*Cleanup operations, \*Dispersants, \*Marine environment, \*Oil pollution, \*Oil spills, \*Path of pollutants, \*Water pollution treatment, Baffin Island, Contingency planning, Ecological effects, Environmental protection, Estuaries, Long Cove, Maine, Panama, Regulations, Wetlands.

The Commission on Engineering and Technical Systems of the National Research Council, was charged to assess the state of the knowledge and practice about the use of dispersants in responding to open ocean oil spills. This assessment will guide federal and local governments and industry in both the United States and Canada, in defining the role of dispersants in oil spill response and implementing the use of dispersants. The committee recommends that dispersants be considered as a potential first response option to oil spills, along with other response options. Implementation of this recommendations must consider spill size, logistical requirements, contingency planning, equipment and dispersant performance and availability, appropriate regulations, and personnel training. Sensitive inshore habitats, such as salt marshes, coral reefs, sea grasses, and mangroves, are best protected by preventing oil from reaching them. Dispersion of oil at sea, before a slick reaches a sensitive habitat, generally will reduce the overall and particularly the chronic impact of oil on many habitats. This has been shown by research studies that compared the biological effects of untreated and dispersed oil released on water over the intertidal or immediate sub-tidal zones at Baffin Island (arctic); Long Cove, Maine (north temperate); and Panama (trop-ical). Although these studies generally showed that dispersed oil caused less chronic environmental that additional ecological studies be conducted, under controlled or naturally established water circulation regimes in shallow environments, to help define the conditions under which dispersant use will be effective and environmentally safe. Because the principal biological benefit of dispersant use is prevention of oil stranding on sensitive shorelines, and because dispersability of oil decreases rapidly with weathering, prompt response is essential. Therefore, the committee recommends that regulations and contingency planning make rapill to establish dispersability in cases of doubt. (

SUPERFUND RECORD OF DECISION: DELA-WARE SAND AND GRAVEL, DE.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-206205. Price codes: A05 in paper copy, A01 in microfiche. Report No. EPA/ROD/R03-88/048, April 1988. 80p, 7 fig, 8 tab, append.

Descriptors: \*Cleanup operations, \*Delaware, \*Delaware Sand and Gravel Site, \*Superfund, \*Volatile organic compounds, \*Water pollution sources, Benzenes, Chromium, Excavation, Groundwater pollution, Incineration, Lead, Monitoring, Organic compounds, Phenols, Polychlorinated biphenyls, Polycyclic aromatic hydrocarbons, Site remediation, Toluene, Waste capping, Waste disposal, Xylenes.

The Delaware Sand and Gravel (DSG) site is a 27 acre inactive industrial waste landfill located in New Castle County, Delaware. It is bordered by Army Creek to the west, and Army Creek and wetlands to the north. Underlying the landfill is the Potomac Aquifer, which is accessed about 1.25 miles south of the site and used as a public water

source. From 1968-1976 the site accepted household construction wastes and approximately 7,000 drums containing liquids and sludges from perfume, plastics, paint, and petroleum refining processes. The primary contaminants of concern affecting the soil and groundwater are VOCs including benzene, toluene, and xylenes, other organics including PCBs, PAHs, and phenols, and metals including chromium and lead. Selected remedial action for the site includes: excavation and on-site mobile incineration of approximately 36,000 tons of contaminated soil and wastes from the Drum Disposal and Ridge areas, with on-site or off-site disposal of residual ash and grading and revegetation of excavated areas; removal and off-site disposal of all surface debris material from the inert area, followed by capping, and construction of a cap over the Grantham South area; groundwater pump and treatment with discharge to Army Creek; and groundwater monitoring. The estimated present worth cost for this remedial action is \$24,944,000. (Lantz-PTT)

SUPERFUND RECORD OF DECISION: PESSES CHEMICAL, TX.

Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-229561. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/ROD/R06-89/047, December 1988. 47p, 3 fig, 4 tab, 3 append.

Descriptors: \*Cleanup operations, \*Heavy metals, \*Pesses Chemical Site, \*Soil contamination, \*Superfund, \*Texas, Batteries, Cadmium, Costs, Excavation, Lead, Nickel, Site remediation, Sludge, Waste capping, Waste disposal.

The 4.2-acre Pesses Chemical Company site is located in Tarrant County, Ft. Worth, Texas. The site is situated in a light industrial and commercial area with an estimated 19,500 people residing or working within a one mile radius. In June 1979, the Presses Company began operations to reclaim cadmium and nickel from dry cell batteries and metal sludges. During July and August 1979, excessive cadmium emissions were investigated by city and state air pollution control offices. Cadmium emissions were measured as high as 2,900 percent above permit limits. In January 1981, the site operations were discontinued. In March 1983, a grass fire at the site resulted in toxic cadmium oxide fumes. Approximately 1,500 deteriorating drums containing heavy metal sludges, powder, and empty battery cases remained on-site. Heavy metals contamination from airborne dust and surface water runoff are the main potential threats at the site. Two sumps in the southern portion of the site contain 1,914 gallons of liquid contaminated with cadmium and nickel. Primary contaminated of contaminated off-site soil and wastes; consolidation with on-site contaminated soil with installation of a concrete cap placed at the south warehouse and office building; and a clay cap placed on the south field. Waters will be treated and discharged into the sewer system. The estimated present worth cost for this remedial action is \$1,200,000, with annual operation and maintenance costs of \$7000. (Lantz-PTT)

### SUPERFUND RECORD OF DECISION: IRON HORSE PARK, MA.

HORSE PARK, MA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-206247. Price codes: A05 in paper copy, A01 in microfiche. Report No. EPA/ROJ/R01-88/026, September 1988. 78p, 3 fig, 4 tab, 2 append.

Descriptors: \*Cleanup operations, \*Iron Horse Park Site, \*Massachusetts, \*Superfund, \*Wastewater lagoons, \*Water pollution sources, Arsenic, Biodegradation, Costs, Groundwater pol-

### Water Quality Control—Group 5G

lution, Heavy metals, Leaching, Lead, Polycyclic aromatic hydrocarbons, Revegetation, Site remedi-ation, Sludge, Soil contamination, Volatile organic compounds, Waste disposal.

The Iron Horse Park site is a 552-acre industrial complex and railyard located in North Billerica, Massachusetts. The site includes manufacturing and railyard maintenance facilities, open storage areas, landfills, and wastewater lagoons. A long history of activities at the site has resulted in history of activities at the site has resulted in contamination of soil, groundwater, and surface water. The site was divided into several separate problem areas. This ROD addresses the cleanup of the Boston and Maine Wastewater lagoons (B and M Lagoons) and surrounding area. The lagoons have been receiving untreated industrial and sanitary wastewater from the manufacturing and railyard maintenance facilities since 1915. The lagoon area consists a North and South lagoon currently receiving wastewater. receiving wastewater, an overflow lagoon, one inactive lagoon used until 1954, and an empty lagoon which was never used. The lagoons contain approximately 7,800 cu yds of soil and sludge contaminated with volatile organic compounds contaminated with volatile organic compounds (VOCs), low level polycyclic aromatic hydrocar-bons (PAHs), and metals. In addition, approxi-mately 20,000 cu yds of soil and sludge dredged from the lagoon bottoms are contaminated with from the lagoon cottoms are contaminated with low levels of organics and metals. The piles of dredged materials and the sludge in the lagoons are considered to not contribute significantly to groundwater contamination. The primary contaminants of concern affecting the soil, sludge, and debris are VOCs, organic PAHs, and metals including arsenic and lead. Selected remedial action for the site includes: excavation and on-site biode-gradation of contaminated soil and sludge with residual disposal to the lagoon area followed by covering with a clean soil cover and revegetation; covering with a clean soil cover and revegetation; and decontamination of the lagoon piping system and pumps. The estimated capital cost for this remedial action is \$2,273,000 with present worth operation and maintenance costs of \$47,000. (Lantz-PTT) W91-10719

SUPERFUND RECORD OF DECISION: SOUTH VALLEY (PL-83), NM. Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Services Servicefield, VA. 21161, pp. 1899 20160. Service, Springfield, VA 22161, as PB89-204812. Price codes: A05 in paper copy, A01 in microfiche. Report No. EPA/ROD/R06-88/043, September 1988. 77p, 7 fig, 2 tab, 6 append.

Descriptors: \*Cleanup operations, \*New Mexico, \*Site remediation, \*South Valley Superfund Site, "Superfund, "Water pollution sources, Air stripping, Extraction, Groundwater pollution, Heavy metals, Methylene chloride, Military reservations, Solvents, Tetrachloroethene, Volatile organic compounds.

The former Air Force Plant 83/General Electric The former Air Force Plant 83/General Electric Operable Unit (PL-83) is a portion of the South Valley Superfund site in the Albuquerque Municipal Water Well known as San Jose No. 6. The General Electric property is located in the western portion of the site, and the south valley site is situated in an industrial area. Contaminants of the South Valley site consist mainly of industrial solvents. The majority of the GE site is covered with paying or buildings. Three areas of contamination have been identified at the site: four hazardous waste storage areas which were used for chemical storage; the north parking lot (a former dirt parking lot which was sprayed with oil as a dust control measure); and the DWB-2 area which con-tains methylene chloride and freon contamination. The volume of contaminated soils is estimated to be 36,000 cu yds. In addition to soil contamination, groundwater contamination occurs at depths of up to 160 ft. The primary contaminants of concern affecting the groundwater and soil are volatile organic compounds (VOCs) including PCE, and metals. Selected remedial action for this site includes: installation of soil vapor extraction wells; extraction of soil water vapor under vacuum; in-stallation of groundwater extraction wells in both the shallow aquifer and the deeper zone; treatment of extracted groundwater with air stripping followed by carbon adsorption and reinjection of treated water into the aquifers; and further definition of groundwater contamination through installation and sampling of additional monitoring wells. The estimated present worth cost for soil remediation is \$1,820,000. No figures are given for the groundwater remedial action. (Lantz-PTT)

FISCAL YEAR 1988 SUPPORTED LIQUID MEMBRANE DEVELOPMENT REPOR Westinghouse Hanford Co., Richland, WA K. M. Hodgson.

Available from the National Technical Information Available from the National Technical Information Service, Springfield, VA 22161, as DE90-001124. Price codes: A03 in paper copy, A01 in microfiche. Report No. WHC-EP-0264, August 1989. 30p, 17 fig. 7 tab, 7 ref. DOE Contract DE-AC06-87RL10930.

Descriptors: \*Groundwater pollution, \*Membrane processes, \*Supported liquid membranes, \*Uranium, \*Water pollution treatment, \*Water treatment, Acids, Laboratory methods, Membranes, Organic compounds, Polypropylene, Pore size, Tempera-

Supported Liquid Membranes have been proposed as a potential process for removing uranium and other contaminants from groundwater. Supported other commands from groundwater. Supporters liquid membrane technology is an emerging technology that has the potential to remove dilute components from a feed stream and concentrate them into a strip solution. A liquid membrane is an organic compound that forms a barrier between the feed stream and the strip stream in a solvent extraction process. A supported liquid membrane is a membrane in which the organic extractant is absorbed in the pores of a microporous membrane support. Two test stands were used for testing done in FY 1988. One test strand was used to test modules, while the other was used in the demor stration of a uranium removal process developed stration of a uranium removal process developed by the Argonne National Laboratory. The models tested were hollow fiber modules containing fibers made from polypropylene. The module testing indicated that in the flow range tested, the flow rate had very little effect on the amount of acid extracted. The testing also showed that membranes on the cu. Inc testing also showed that memoranes on the smaller pore size support were more stable than the large pore size support, and that increasing the temperature increased the extraction rate but decreased the membrane stability. (Author's abstract) W91-10727

PERMITTING NONPOINT SOURCES: PROGRAMS, PROVISIONS, PROBLEMS AND PO-TENTIAL.

Harvard School of Public Health, Boston, MA. A. Rosenthal.

A. Rosenthal.

Available from the National Technical Information
Service, Springfield, VA. 22161, as PB89-186712.

Price codes: A09 in paper copy, A01 in microfiche.
EPA Report No. EPA/600/9-89/035, January
1989. 179p, 2 fig, 2 tab, 6 append. National Network for Environmental Policy Studies Fellowwork or Environmental Policy Studies Fellowship No. u-913018-01.

Descriptors: \*Legal aspects, \*Nonpoint pollution sources, \*Permits, \*Water pollution control, Agricultural runoff, Best management practices, Model studies, Settling basins, Standards, Storm runoff,

In recent years, an increasing number of states and local agencies have instituted permitting programs to control nonpoint source (NPS) water pollution. Permits are issued to both urban and agricultural NPS generators. NPS permit applications typically NPS generators. NPS permit applications typically require a range of maps and support documentation that help indicate the impact of the operation on water quality. Permit applicants rely heavily on consulting engineers to design the best management practices (BMPs) allowed in the permit. Most NPS permits conform to design standards which detail BMP specifications, rather than to performance standards which limit the amount or pollutant concentration of allowable runoff. For such a NPS permitting system to ensure water quality, howevpermitting system to ensure water quality, however, permits should include reopener clauses or

expire periodically. This would allow for modifications in response to the dynamic ambient condi-tions of receiving waters. Although permits for both agricultural and urban NPS discharges tend to require retention or detention structures, other nonstructural BMPs are increasingly included in permit conditions. The Water Quality Act's storm-water provisions and EPA's proposed regulations are primarily procedural in nature and do not stipulate the form or stringency of stormwater permits. Enforcement of NPS permits should proactively utilize inspection programs to prevent violations. Aerial surveillance can help to suppleviolations. Aerial surveillance can help to supple-ment personnel shortages. Once a deficiency is identified, the decision to initiate enforcement action should be based primarily on the potential for adverse impacts upon receiving waters. Other factors should include the extent of the deficiency and existence of past violations. There are many sociological, economic and political factors which sociological, economic and political factors which appear to influence the success of a NPS permitting program. While cost-sharing programs may enhance the effectiveness of a permitting system, most regulatory programs for NPS have actually arisen because of the absence of such nonregulatory programs. Because most NPS permitting systems have been established only recently, there is an absence of evaluation literature assessing their effectiveness either in terms of permittee complian absence of evaluation increasing assessing their effectiveness either in terms of permittee compliance or water quality impact. Yet, it appears that NPS permitting programs are becoming increasingly comprehensive and effective in their efforts to reduce runoff. (Lantz-PTT) W91-10730

STATUS OF GROUND WATER IN THE 1100

Westinghouse Hanford Co., Richland, WA. For primary bibliographic entry see Field 5B. W91-10732

BIOTECHNOLOGY DEGRADATION AND MITIGATION OF OFFSHORE OIL SPILLS, PHASE 1. MAIN REPORT: TECHNOLOGY TO ENHANCE BIODECRADATION OF OIL SPILLS STATE OF THE ART AND PERSPEC-TIVES EQUI TECHNOLOGY DEVEL OPMENS TIVES FOR TECHNOLOGY DEVELOPMENT. Norsk Petroleumsinstitutt, Oslo.

T. Bakke, T. Briseid, G. Eidsa, R. G. Lichtenthaler, and E. Nordgaard.

Available from the National Technical Information Service, Springfield, VA. 22161, as DE88-757318. Price codes: A03 in paper copy, A01 in microfiche. Report No. NIVA-O-86095, December 4, 1986.

Descriptors: \*Biodegradation, \*Biotechnology, \*Cleanup, \*Marine environment, \*Oil spills, \*Water pollution treatment, Bacteria, Biological treatment, Dispersants, Fertilizers, Nitrogen, Oil pollution, Phosphorus.

Many marine microorganisms have the ability to metabolize and mineralize oil. Bacteria are, in genmetabolize and mineralize oil. Bacteria are, in gen-eral, regarded as the most important group, as are fungi, yeasts, cyanobacteria and to some extent microalgae able to degrade oil. A potential for biodegradation of oil therefore exists in most marine environments. Biodegradation occurs at the oil-water interface. Dispersion (physical or chemi-cal) of oil in the water will greatly increase this interface as well as the surface-to-volume ratio of the oil, and is therefore a necessary condition for significant biodegradation to occur. Means to insignificant biodegradation to occur. Means to in-crease oil-in-water dispersion (dispersants, emulsion inhibitors, and other surfactants) are thus the most promising starting points for development of the desired biodegradation technology. In general, the rate of biological processes decrease with decreasing temperature. The microorganisms need mineral nutrients such as nitrogen, phosphorus, and iron to utilize oil. Application of organic N and iron to utilize oil. Application of organic is and P containing nutrients is a way to provide these nutrients, especially with 'lipophilic fertilizers' which tend to adhere to or mix with the oil, and are thus readily available for utilization by the microorganisms on the oil. One basic philosophy for the research needed to develop oil combat technology, on the basis of biodegradation, is therefore to combine technology to disperse the oil

### Group 5G-Water Quality Control

(dispersants and emulsion inhibitors) with addition of oil soluble fertilizers. The advantage of adding microbial cultures (mixed or single species) as a means to accelerate the oil degradation rate is uncertain. It is also doubtful if 'superbugs', or uncertain. It is also doubtful if 'superbugs', or specialized bacteria produced through genetic engineering, can meet requirements of effectiveness, adaptivity to storage and various ecological regimes, and lack of pathogenicity. Sorbents have proven to be efficient in trapping oil for easy untake by mechanical means but due to the limited uptake by mechanical means, but due to the limited supply of oxygen and nutrients in the oil-sorbent material, they are regarded as less favorable for oil degradation than dispersants and emulsion inhibitors. (Lantz-PTT) W91-10735

#### SUPERFUND RECORD OF DECISION: REICH FARMS, NJ.

FARMS, NJ. Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Service, Springfield, VA. 22161, as PB89-206254. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/ROJ/R02-88/070, September 1988. 104p, 4 fig, 6 tab, append.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Site remediation, \*Superfund, \*Water pollution sources, Air stripping, Aquifers, Costs, Excavation, New Jersey, Organic compounds, Tetrachitoreethylene, Trichloroethane, Volatile organic compounds, Water pollution treatment.

The Reich Farm site is located in Dover Township, Ocean County, New Jersey. The site is ap-proximately one mile northeast of the Toms River, but no floodplains or wetlands are affected by the but no floodplains or wetlands are affected by the site. In August 1971, a portion of the land was rented for the temporary storage of used 55-gal drums. Most of the drums had Union Carbide Corporation (UCC) markings on them, with labels reading 'tar pitch,' 'lab waste solvent,' 'blend of resin and oil,' and 'solvent wash of process stream' among others. The site first came to the attention of the New Jersey Superior Court when the Reichs filed suit against UCC and other previous owners. UCC undertook drum removal and completed the work in March 1972. In June 1974, another 51 drums and approximately 1,100 cu yd another 51 drums and approximately 1,100 cu yd of contaminated soil and trenched wastes were removed from the site, but residents near the site had already complained about an unusual taste and odor in their well water. Based on results of an extensive sampling program, the Dover Township Board of Health ordered 148 private wells closed, and established a zoning ordinance restricting groundwater use in the area of the Reich Farm. The volume of contaminated soil remaining at the site is estimated to be 2,010 cu yd. The primary contaminants of concern affecting the groundwater and soils are volatile organic compounds (VOCs) including 1,1,1-trichloroethane (TCA), trichloroethene, tetrachloroethylene, and semi-volatile organic compounds. The selected remedial action for odor in their well water. Based on results of an ganic compounds. The selected remedial action for this site includes: additional groundwater sampling to further delineate the leading edge of the con-taminant plume and additional soil sampling to support existing data on contaminants of concern support existing data on contaminants of concern at the site; groundwater pump and treatment using air stripping and carbon adsorption with reinjec-tion of the treated water back into the aquifer; and excavation and storage of surface soils on-site, excavation and storage of surface soils on-site, which do not require remediation. The estimated present worth cost for this remedial action is \$5,832,000, which includes annual operation and maintenance costs of \$419,550. (Lantz-PTT) W91-10743

#### AKE LANSING DREDGING EVALUATION STUDY, 1978-1984.

Michigan Dept. of Natural Resources, Lansing. R. Mikula.

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-208763. Price codes: A06 in paper copy, A01 in microfiche. March, 1985. 104p, 17 fig, 7 tab, 22 ref, 2 append.

Descriptors: \*Dredging, \*Ecological effects, \*Lake Lansing, \*Lake restoration, \*Water quality, Arsenic, Chlorophyll a, Eutrophic lakes, Kjeldahl

nitrogen, Limnology, Mercury, Michigan, Nitrates, Nitrites, Oxygen, Phytoplankton, Species composition.

Lake Lansing is located seven miles east of Lansing, Michigan. Prior to dredging the lake was eutrophic, had a surface area of 182 hectares (approximately 450 acres), a maximum depth of 11 meters (35 feet), and a mean depth of somewhere between 2.1 and 2.3 meters (7.0 to 7.5 feet). Between May, 1978 and August, 1983 approximately 1.6 million cu yd of soft sediment were removed from the lake and 220,890 cu yd of sand were redistributed within the lake. Surface area and maximum depth remained the same after dredging as before, but the mean depth increased to 2.7 meters (9.0 feet). Comparison of pre-dredging and post-dredging data reveals an increase in transparency and substantial reductions in in-lake phosphorus and chlorophyll a. Some reduction in total rus and chlorophyll a. Some reduction in total Kjeldahl nitrogen occurred. Changes in nitrate + nitrite and oxygen depletion were not evident. Trophic status of Lake Lansing improved from a highly eutrophic condition to a meso-eutrophic condition. Heavy metals, specifically arsenic and mercury, were not remobilized during dredging. Benthic macroinvertebrate communities did not change in composition, but did exhibit an increase in number of individuals after dredging. Composiin number of individuals after dredging. Composi in number of individuals after dredging. Composi-tion of the fish community was poor prior to and after dredging. Phytoplankton communities dis-played a seasonal diversity of types which varied in patterns typical of mesotrophic and/or eutro-phic lakes. Zooplankton populations did not change in composition, but did exhibit a decrease in number of individuals after dredging. Additional surveys will be conducted by the Michigan De-partment of Natural Resources prior to implement-ing management strategies. (Lantz-PTT) W91-10748

### SUPERFUND RECORD OF DECISION. MID-STATE DISPOSAL LANDFILL, WI. Environmental Protection Agency, Washington,

DC

DC. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-189559. Price Codes: A04 in paper copy, A01 in microfiche. Report No. EPA/ROD/RO5-88/076, September 1988. 55p, 4 fig, 7 tab.

Descriptors: \*Cleanup operations, \*Landfills, \*Site remediation, \*Superfund, \*Water pollution sources, \*Wisconsin, Benzenes, Costs, Drainage, Groundwater pollution, Leachates, Monitoring, Path of pollutants, Tetrachlorethylene, Trichloroethane, Volatile organic compounds, Waste capcing.

The Mid-State Disposal (MSD) site is an abandoned municipal and industrial waste landfill located in central Wisconsin, about 4 miles northeast of Stratford. Site runoff enters nearby waterways in-cluding the Rock Creek and Eau Plune River via unnamed tributaries. Additionally, groundwater from the site is believed to be discharging into a ravine 500 feet south of the site. MSD conducted landfilling operations from 1970-1979, receiving municipal, industrial and commercial wastes as municipal, industrial and commercial wastes as well as construction and demolition debris. Specific wastes received included papermill sludges, asbestos dust, solvents, pesticides, paint sludges and metals. In 1979, Weyerhaeuser Company, a generator of waste disposed at the facility, agreed to properly abandon the facility. The pond leachate was removed, and the three waste disposal areas were covered. Leachate collection systems were installed in late 1979 for both the sludge lagoon and the Interim Expansion area; only the leachate and the Interim Expansion area; only the leachate collected from the latter is currently removed and treated off-site. Subsequent investigations revealed that groundwater has been contaminated by leachate percolating from the waste disposal areas and the leachate pond down to the underlying aquifer. The primary contaminants of concern affecting the groundwater, surface water and soil are volatile organic compounds including benzene, tetrachlor-oethylene, and trichloroethane, and metals. The selected remedial action for this site includes: installation of new soil/clay caps for the lagoon and landfills; site monitoring that includes groundwater, surface water, and landfill gas monitoring; off-

site groundwater monitoring; provision of an alter-nate water supply for nearby residences; improve-ment of surface water drainage; leachate and ponded water collection and offsite treatment; and, in situ solidification/stabilization of sludge as necessary for cap support. The estimated present worth for this remedial action is \$16,000,000 with annual operation and maintenance of \$22,000 for the first year, and \$100,000 for years 2-30. (Lantz-

W91-10749

### AMBIENT WATER QUALITY CRITERIA FOR AMMONIA (SALTWATER)-1989.

Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-195242. Price codes: A05 in paper copy, A01 in microfiche. EPA Report 440/5-88-004, April 1989. 76p, 7 tab, 146 ref, 2 append.

Descriptors: \*Ammonia, \*Ecotoxicology, \*Saline water, \*Standards, \*Water pollution control, \*Water quality, Aquatic life, Estuaries, Marine environment, Toxicity.

Ammonia is a common and highly toxic pollutant which, in sufficient quantities, will adversely affect aquatic organisms. The ammonia criteria document for salt water will allow establishment of regulatory standards for ammonia discharge into estuaries, near coastal zones and oceans. Possible adverse invects in highly sensitive and abundant aries, near coastan zones and oceans. Possible activerse impacts in highly sensitive and abundant ecosystems such as estuaries make regulation particularly important. Except where locally important species are very sensitive, salt water aquatic organisms should not be affected unacceptably if. (1) the criterion continuous concentration for unionized ammonia does not exceed 0.035 mg/L more than once every three years on average more than once every three years on average (chronic exposure expressed as a 4-day average); and (2) the criterion maximum concentration (acute exposure expressed as a one-hour average) does not exceed 0.233 mg/L more than once every three years on the average. Because many salt water organisms have a narrow range of acute sensitivity to ammonia, these criteria will probably hear evertexitie as intended cally when the exposure of the contraction be as protective as intended only when the magnitude and/or durations of criteria exceedence are appropriately small. It is particularly important to recognize that variability of exposure will be relatively high in tidal saltwater ecosystems due to changes in available dilution as the tide recedes, and incomplete flushing of estuaries. (Author's abstract) W91-10750

## SUPERFUND RECORD OF DECISION: KIN-BUC LANDFILL, NJ.

Environmental Protection Agency, Washington,

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-189500. Price codes: A05 in paper copy, A01 in microfiche. EPA Report ROD/RO2-88/068, September 1988. 70p, 6 fig, 5 tab, 5 append.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Kin-Buc Landfill, \*New Jersey, \*Raritan River, \*Site remediation, \*Superfund, \*Water pollution sources, Arsenic, Benzenes, Costs, Heavy metals, Incineration, Lead, Monitoring, Polychlorinated biphenyls, Toluene, Volatile organic compounds, Waste capping.

The 220-acre Kin-Buc Landfill consists of a number of inactive industrial and municipal waste number of inactive industrial and municipal waste disposal areas and is located in the Raritan River 100-year flood plain and within a coastal zone in Edison Township, Middlesex County, New Jersey. Landfill operations were conducted between 1947 and 1977. According to site records, an estimated 70 million gallons of liquid wastes, including 3 million gallons of oily waste and over 1 million tons of solid waste, were disposed of between 1973 and 1976 alone. Examples of wastes received in-clude solvents, waste oils, paint sludges, cyanides, metal stripping wastes and paint thinners. Site ac-tivities included burying and compacting contained

## Water Quality Control—Group 5G

wastes in Kin-Buc II, and discharging hazardous liquid wastes into bulldozed pits at the top of Kin-Buc I. EPA began investigations in January 1976 and detected the discharge of hazardous substances from the facility. In February 1980, EPA began cleanup activities consisting of collection, treatment, and disposal of Pool C leachate; a drum neuti, and utsposal of root reachate; a drum reduction program; oil-phase leachate collection and onsite storage; and aqueous-phase leachate pretreatment, removal, and offsite treatment. In September 1980, Kin-Buc, Inc. was ordered to cap Kin-Buc I and II. The primary contaminants of concern affecting the groundwater, surface water, sediments, soil and air are: volatile organic compounds including benzene and toluene, other organics including polycyclic aromatic hydrocarbons and polychlorinated biphenyls, and metals including arsenic and lead. The selected remedial action for this site includes: installation of a slurry wall surrounding the site; RCRA capping over Kin-Buc II; collection of approximately 3 million gallons of oily-phase leachate with off-site incineration and residual disposal; collection and on-site biological or carbon treatment of aqueous-phase leachate and contaminated groundwater and dewatering of residual sludges and offsite disposal; and, groundwatreduction program; oil-phase leachate collection contaminated groundwater and dewatering of re-sidual sludges and offsite disposal; and, groundwat-er monitoring. The estimated present worth cost for this remedial action is between \$16,290,000 and \$16,635,000 with annual O&M varying from \$848,000 (year 1) to \$405,000 (years 12-20). (Au-thor's abstract) thor's abstract) W91-10755

SUPERFUND RECORD OF DECISION: PALMERTON ZINC PILE, PA.

Environmental Protection Agency, Washington,

DC. Available from the National Technical Information Service, Springfield, VA 22161, as PB89-204762. Price codes: A04 in paper copy, A01 in microfiche. EPA Report ROD/RO3-88/063, September 1988. 60p, 4 fig, 1 tab, 2 append.

Descriptors: \*Cleanup operations, \*Palmerton Zinc Site, \*Pennsylvania, \*Site remediation, \*Superfund, \*Water pollution sources, Cadmium, Diversion channels, Groundwater pollution, Heavy metals, Leachates, Lead, Monitoring, Vegetation, Waste capping, Wastewater lagoons, Wetlands wastewater treatment, Zinc.

The Palmerton Zinc site is composed of two locations in the Borough of Palmerton, Carbon tions in the borough or raimerton, Carooni County, Pennsylvania. Smelting operations have been conducted at two locations, a west smelter and an east smelter, flanking the Town of Palmer-ton, which is located at the confluence of the ton, which is located at the commence of the Lehigh River and Aquashicola Creek. The drain-age pattern in the site area is toward Aquashicola Creek, designated a warm water fishery by the State of Pennsylvania, which flows into Lehigh River. Smelting operations were conducted in the west plant from 1898 to 1987, and in the east plant from 1911 to present. Between 1898 and 1987 process residue and other plant wastes (as well as municipal waste until 1970) were disposed of on Cinder Bank, a 2.5-mile, 2,000-acre waste pile lo-cated behind the east plant at the base of the Blue Mountains. Cinder Bank contains approximately 27.5 million tons of leachable metals including lead, zinc, and cadmium, as well as carbonaceous material. Large blocks of residue crack and break off, allowing rapid infiltration of runoff during periods of rain and snow melt, resulting in contaminated leachate percolating down to the groundwater and seeping out of Cinder Bank. This remedial action addresses Cinder Bank. Additional areas of contamination as well as groundwater and surface water contamination will be addressed in subsequent remedial actions. The primary contami-nants of concern affecting the sediments, groundwater, and surface water are metals including cad-mium, lead and zinc. The selected remedial action for this site includes: slope modification, capping, and application of a vegetative cover on Cinder Bank; construction of surface water diversion channels; surface water and leachate collection and treatment using lime-activated filtration lagoons and/or constructed wetlands; implementation of an inspection, monitoring, and maintenance plan; and wetlands restoration measures, if necessary. The estimated present worth cost for this remedial action will be in excess of \$2,861,800; however, the exact figure will not be known until agreement is reached on the extent of remediation during reme-dial design. (Author's abstract)
W91-10756

SUPERFUND RECORD OF DECISION: SOUTH VALLEY/EDMUNDS STREET, NM. Environmental Protection Agency, Washington,

DC. Available from the National Technical Information Service, Springfield, VA 22161, as PB90-107558. Price codes: A03 in paper copy, A01 in microfiche. EPA Report ROD/R06-89/048, March 1989. 41p, 3 fig, 1 tab, 3 append.

Descriptors: \*Groundwater quality, \*Site remediation. \*South Valley Superfund Site, \*Superfund, \*Water pollution sources, Cleanup operations, Military reservations, New Mexico, Soil contami-

The South Valley/Edmunds Street site is a portion of the South Valley Superfund site-a large area in the southern part of the city of Albuquerque, New Mexico. The site has been divided into operable Mexico. The site has been divided into operable units to address soil and groundwater contamination resulting from current and historical industrial practices. The operable units include Edmunds Street Ground Water, Former Air Force Plant 83/GE, San Jose-6, and the final operable unit, Edmunds Street Source Control. Potential sources of groundwater contamination within the Edmunds Street property have been identified, but primary focus has been given to a drainage pit area which receives most of the drainage from the property. Investigations in all of the suspected potential contaminant source areas. however, revealed little soil taminant source areas, however, revealed little soil contamination. Even if further migration of concontamination. Even if further migration of con-taminants to groundwater occurs, the groundwater treatment system developed in the previous Ed-munds Street Ground Water operable unit will be sufficient to address these concerns. There are no contaminants of concern affecting the soil at this site. The selected remedial response for this final operable unit is no further action. Based on samoperable unit is no further action. Based on sampling data, the soil has been determined to contain contaminant levels below hazardous contaminant concentration limits and poses no risk to human health or the environment. The only further activineattn or the environment. The only further activi-ties anticipated at the site are sampling of soil gases in the drainage pit area following the groundwater remedial action, and the precautions necessary to prevent any disturbance of drainage pit soils during the groundwater remediation. There are no remedial or O&M costs associated with this opera-ble unit. (Author's abstract) W91-10758

SUPERFUND RECORD OF DECISION: CEL-ANESE FIBERS OPERATIONS, NC.

Environmental Protection Agency, Washington,

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-196729. Price codes: A05 in paper copy, A01 in microfich. EPA Report ROD/RO4-88/038, March 1988. 77p, 4 fig, 3 tab, 3 append.

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Industrial wastewater, \*North Carolina, \*Site remediation, \*Superfund, Adsorption, Adsorpti na, 'Sale remediation, 'Superintin, Adsorption, Air stripping, Benzenes, Biological treatment, Buffalo Creek, Chemical precipitation, Chromium, Costs, Phenols, Tetrachloroethylene, Volatile organic compounds, Water pollution sources.

The 450-acre Celanese Fiber Operations (CFO) site is occupied by a polyester raw-material production facility, and is located in Cleveland County, one mile north of Earl, North Carolina. The plant began operations in 1960 as Fibers Industries, Inc, manufacturing polyester polymer chip and filament yarn using the chemicals dimeth-yl terephthalate and ethylene glycol. Celanese Corporation bought the facility in 1983. The CFO waste treatment plant was constructed in phases concurrent with the manufacturing plant. This resulted in the disposal of chemical wastes directly into a drainage ditch during the early years of operation prior to completion of the waste treat-

ment plant. Treated effluent has been discharged to ment plant. Treated effluent has been discharged to Buffalo Creek since the mid-1960s, when CFO completed construction of the treatment plant. In addition to the discharge from the wastewater treatment plant, CFO also discharges alum-treated bandcaster water directly to Buffalo Creek. Several areas around the plant have been used for waste disposal, including old burning pits for normal plant wastes (polyester and trash), a glycol recovery unit sludge burial area, and a former drum storage and staging area (drums contained solutions that failed to polymerize) excavated and backfilled in the mid-1960s, and two soak-away ponds formerly containing treated sanitary sewage. ponds formerly containing treated sanitary sewage. The primary contaminants of concern affecting the groundwater include: volatile organic compounds including benzene and tetrachloroethylene, organics including phenols, and metals including chromium. The selected remedial action for this site includes: groundwater pump and treatment using air stripping, biological treatment, and carbon adsorp-tion (if necessary), followed by discharge to the on-site wastewater treatment plant. If the treat-ment system effluent contains metals, such as chroment system entural contains metals, such as Caro-mium, above allowable discharge levels, the efflu-ent will be treated using chemical precipitation. The estimated present worth cost for this remedial action if \$2,032,000 with estimated present worth O&M of \$1,069,230. (Author's abstract)

MECHANISTIC EVALUATION OF MITIGA-TION OF PETROLEUM HYDROCARBON CONTAMINATION BY SOIL MEDIUM.

McGill Univ., Montreal (Quebec). Geotechnical Research Centre

Research Centre.
R. N. Yong, and S. M. Rao.
Canadian Geotechnical Journal CGJOAH, Vol. 28, No. 1, p 84-91, February 1991. 4 fig. 5 tab, 32 ref. National Sciences and Engineering Research Council of Canada Grant No. A82.

Descriptors: \*Cleanup operations, \*Hydrocarbons, \*Oil pollution, \*Soil contamination, \*Soil mechanics, \*Soil treatment, \*Water pollution treatment, Adsorption, Bonding, Chemical interactions, Clays, Hydraulic conductivity, Permeation, Polymers, Soil physical properties, Solubility, Sorption.

Various in situ chemical treatment technologies are being developed for mitigation of petroleum hydrocarbon contamination. One treatment for restricting the movement of petroleum hydrocarbon stricting the movement of petroleum hydrocarbon (PHC) molecules in the contaminated soil utilizes the sorption-interaction relationships between the petroleum contaminants and the soil substrate. Petroleum hydrocarbons comprise a mixture of non-polar alkanes and aromatic and polycyclic hydrocarbons that have limited solubility in water. The bonding mechanism between the nonpolar PHC's and the clay surface is by way of van der Waals attraction. The adsorption of the nonpolar hydrocarbons by the clay surface occurs only when the carbons by the clay surface occurs only when the solubility of the hydrocarbon molecules in water is solubility of the hydrocarbon molecules in water is exceeded and the hydrocarbons exist in the micellar form. Dilute solutions of hydrocarbons in water, i.e., concentrations of hydrocarbons at or below the solubility limit, have no effect on the hydraulic conductivity of clay soils. Permeation with pure hydrocarbons invariably influences the clay's hydraulic conductivity. To improve the attenuation ability of soils towards PHC's, it is proposed that the soil surface be coated with 'ultra' heavy organic polymers. Adsorption of organic polymers. posed that the soil surface be coated with 'ultra' heavy organic polymers. Adsorption of organic polymers by the clay surface may change the surface properties of the soil from highly hydrophilic (having affinity for water molecules) to organophilic (having affinity for organic molecules). The organic polymers attached to the clay surface are expected to attenuate the PHC molecules by van der Waals attraction, by hydrogen bonding, and also by adsorption into interlayer space in the case of soils containing swelling clavs. (Author's case of soils containing swelling clays. (Author's abstract) W91-10779

AQUEOUS SURFACTANT WASHING OF RE-SIDUAL OIL CONTAMINATION FROM SIDUAL OIL

General Motors Research Labs., Warren, MI. En-

### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

## Group 5G-Water Quality Control

vironmental Science Dent Virolmental Science Dept. C. C. Ang, and A. S. Abdul. Ground Water Monitoring Review GWMRDU, Vol. 11, No. 2, p 121-127, Spring 1991. 6 fig, 5 tab,

Descriptors: "Cleanup, "Oil, "Site remediation, "Soil contamination, "Soil treatment, "Surfactants, Dispersion, Experimental design, Rehabilitation, Sand, Soil columns, Solubility, Solute transport,

A laboratory study was conducted to determine the efficiency of different aqueous concentrations of an alcohol ethoxylate surfactant in washing residual levels of an oil (automatic transmission fluid (ATF)) from sandy soil. Five glass columns packed with the soil were prepared in a manner that simulated conditions leading to residual saturation in an actual oil leak. Each of four columns was washed continuously with 28 pore volumes of solution by pumping either 0.0 percent (water), 0.5 percent, 1.0 percent, or 2.0 percent aqueous surfactant solutions through the columns. The fifth column was washed intermittently with 28 pore volumes of a 1.0 percent surfactant solution. Water column was washed intermittently with 28 pore volumes of a 1.0 percent surfactant solution. Water washed only 25.5 percent of the ATF from the column soil, while the 0.5 percent, 1 percent, and 2 percent surfactant solutions washed 55 percent, 60 percent, and 72.8 percent of the ATF, respectively. The distribution of the ATF remaining in the column after washing showed that the ATF removed by water was mainly from the outlet side of the column, while the ATF removed by the 2.0 percent surfactant solution was mainly from the percent surfactant solution was mainly from the inlet side of the column. This observation indicated that different mechanisms were involved; namely, the displacement of oil through the soil-pore space, the dispersion of oil due to reduced surface ten-sion, and the solubilization of oil by surfactant micelles. The results show promising potential for application in the field and will be further investigated in a two-dimensional model aquifer. (Au-

COMPUTER MODELING OF SCALE FORMA-TION DURING TREATMENT OF GROUND WATER IN AIR STRIPPERS.

WATER IN AIR STRIPPERS.
Case Western Reserve Univ., Cleveland, OH.
Dept. of Geological Sciences.
G. Matisoff, and C. Narquis.
Ground Water Monitoring Review GWMRDU,
Vol. 11, No. 2, p 137-144, Spring 1991. 2 fig, 2 tab,

Descriptors: \*Air stripping, \*Computer models, \*Groundwater pollution, \*Model studies, \*Scaling, \*Water pollution treatment, \*Water treatment, Calcium carbonate, Carbon dioxide, Chemical precipitation, Equilibrium, Flow models, Hydrogen ion concentration, Iron, Iron compounds, Oxidation Medicial Securic compounds tion, Volatile organic compounds

During treatment to remove volatile organic com-pounds from contaminated groundwater, inorganic scale sometimes precipitates in an air stripper tower. This leads to increased costs and down-time associated with tower media replacement. In order to determine the kind, quantity, and rate of scale to determine the kind, quantity, and rate of scale formation, the groundwater from five locations in Florida was simulated using an aqueous equilibrium chemistry and flow process model. In all cases the pH of the outflow water is higher than that of the inflow water because of degassing of CO2. This often results in the precipitation of calcium carbonate. The addition of air to reduced groundwater than the control of the c water results in the oxidation of iron and the precipitation of ferric hydroxides. Model estimates of scale formation are about a factor of two to five too high. This indicates that the precipitation reactions do not reach equilibrium within the air strip-per. Future work will require the inclusion of biological fouling and a kinetic expression to ac-count for the observed non-equilibrium. (Author's abstract) W91-10798

DEVELOPMENT AND IMPLEMENTATION OF A REMEDIAL INVESTIGATION WORK PLAN AND DATA MANAGEMENT SYSTEM.

C. M. Olson. Ground Water Monitoring Review GWMRDU, Vol. 11, No. 2, p 145-152, Spring 1991. 8 fig.

Descriptors: \*Cleanup, \*Data management, \*Databases, \*New Jersey, \*Site remediation, \*Waste disposal, Management planning, Network design, Operating policies, Remedial investigation, Sampling.

The Pompton Lakes Works (PLW) is a 580-acre ine rompton Lakes works (PLW) is a 300-acre industrial facility located in northern New Jersey that has manufactured explosives for more than 100 years. Waste from these operations was disposed of on-site and a remedial investigation (R1) was initiated to determine the extent of contamina was initiated to determine the extent of containina-tion. Conducting an RI at a complex industrial facility calls for an RI work plan that addresses not facility calls for an RI work plan that addresses not only the investigative aspects but also lays the groundwork for the operational aspects. Prior to the development of the RI work plan, the preparatory work identified the special problems or advantages at the facility so they can be incorporated into the overall RI. The operational aspects to be considered in the PI work plan was the steffice. considered in the RI work plan were the staffing requirements, the inconsistent workload of an inrequirements, the inconsistent workload of an investigation, and the tremendous amount of data that would be generated. These issues were addressed in the RI work plan and by the development of a database management system. The database management system provided a cyclical format with repeatable loops to issue sample plans, concurrent reports on each phase, or summary reports. By putting care and thought into the development of an RI work plan and the concurrent development of a database management system. development of a database management system, PLW has been able to operate an RI at a large industrial facility in a cost-effective and thorough manner. (Korn-PTT) W91-10799

ITERATIVE EVALUATION OF A LAKE WATER QUALITY MANAGEMENT PRO-

GRAM. Cassandra Consulting Co., Kenoza Lake, NY. J. Herring, and J. Powell. Water Resources Bulletin WARBAQ, Vol. 26, No. 6, p 893-899, December 1990. 2 fig, 14 ref.

Descriptors: \*Interagency cooperation, \*Keuka Lake, \*Lake management, \*New York, \*Water policy, \*Water pollution management, Decision making, Evaluation, Local governments, Policy making, Water resources

Local governments often face environmental prob-lems that cross political boundaries. The onus for solution falls on the most severely affected jurisdiction, others do nothing until impacted. Resolution tion, others do nothing until impacted. Resolution of these problems requires cooperation across political boundaries which means that local governments must be persuaded first that there is a problem, and second that action is required to solve it. An iterative, low cost methodology has been developed which can supply credible information to help achieve consensus on solutions to environmental problems. These ideas were developed from experience with an evaluation of a waterquality protection program on Keuka Lake (one of the Finger Lakes) in New York State. Local government officials and residents in the watershed the Finger Lakes) in New York State. Local gov-ernment officials and residents in the watershed were concerned with a rapid increase in rooted aquatic vegetation (particularly Myriophyllum spi-catum, Eurasian water milfoil) which was affecting tourism. The lake is bordered by two incorporated tourism. The lake is bordered by two incorporated villages and six towns in two counties; thus, the environmental issue extended across political boundaries. An iterative program-evaluation strategy was developed to provide information in three areas: (1) Assessment of the role of upland sources in lake nutrient loading-eighteen months of stream sampling provided acceptable evidence that upland areas were not a significant nutrient source; (2) Assessment of the role of lakeshore development Assessment of the role of lakesnore development on lake water quality—a survey of septic system data in the Watershed Inspector's records and an in-lake coliform bacteria sampling program indicated that there may be some significant problems associated with failing septic systems; and (3) Determination of residents' attitudes and perceptions because the water quality—a mill survey of regarding lake water quality-a mail survey of property owners showed policy makers in all six

towns that support existed for a watershed district. A committee was elected to develop draft legislation to form a water-quality management district which will address lake-wide issues such as adequacy of septic system regulation, land use, erosion control, and construction activities. (Korn-PTT) W91-10808

BUFFER STRIPS TO PROTECT WATER SUPPLY RESERVOIRS: A MODEL AND REC-OMMENDATIONS

Cook Coll., New Brunswick, NJ. Dept. of Enviental Resou

G. H. Nieswand, R. M. Hordon, T. B. Shelton, B. B. Chavooshian, and S. Blarr.

Water Resources Bulletin WARBAQ, Vol. 26, No. 6, p 959-966, December 1990. 4 fig. 1 tab, 40 ref. New Jersey Department of Environmental Protection Contract No. C29010.

Descriptors: \*Buffer zones, \*Model studies, \*Reservoirs, \*Water pollution control, \*Water pollution prevention, \*Water quality management, \*Water supply, \*Watershed management, Buffer strips, New Jersey, Nonpoint pollution sources, Traveltime, Vegetation effects.

Buffer strips are undisturbed, naturally vegetated zones around water supply reservoirs and their tributaries that are a recognized and integral aspect of watershed management. These strips can be very effective in protecting the quality of public very effective in protecting the quality of public potable water supply reservoirs by removing sediment and associated pollutants, reducing bank erosion, and displacing activities from the water's edge that represent potential sources of nonpoint source pollutant generation. As part of a comprehensive watershed management project for the State of New Jersey, a parameter-based buffer strip model was developed for application to all watersheds above water supply intakes or reservoirs. Input requirements for the model include a combination of slope, width, and time of travel. The application of the model to a watershed in New Jersey with a recommended buffer strip width that ranges from 50 to 300 feet, depending upon a number of assumptions, results in from 6 to 13 percent of the watershed above the reservoir being occupied by the buffer. (Author's abstract) occupied by the buffer. (Author's abstract) W91-10816

BACTERIOPHAGES AS MODEL VIRUSES IN WATER QUALITY CONTROL.
Water Research WATRAG, Vol. 25, No. 5, p 529-

545, May 1991. 1 fig, 2 tab, 162 ref.

Descriptors: \*Bacteriophage, \*Bioindicators, \*Enteroviruses, \*Viruses, \*Water pollution control, \*Water quality control, \*Water treatment, Culturing techniques, Literature review, Path of pollutants, Pollutant identification, Standards.

The potential of using bacteriophages as models for the fate of viruses in natural waters and water treatment is reviewed with special attention to the somatic coliphages, the F-specific RNA phages and phages of Bacteroides fragilis. Enumeration from highly contaminated samples can be achieved by plaque counts or enrichment methods; for less by plaque counts or emicration medicas, to polluted samples a variety of concentration procedures is available, derived mainly from techniques developed for enteroviruses. International standdeveloped for enteroviruses. International st ardization of methods is necessary to promote fur-ther development of the field. Bacteriophages have promise as process indicators for viruses. F-specific RNA bacteriophages are a more homogeneous RNA bacteriophages are a more homogeneous group than somatic coliphages and have generally a greater resistance. The value of somatic coliphages is further limited by their ability to multiply in unpolluted waters. Both groups are an index of sewage contamination rather than fecal contamination, hence their ecology is different from human enteric viruses. Phages of Bacteroides fragilis have been reported to occur exclusively in human feces well that is the source beautiful the statement of the second properties. but little is known about their behavior in water treatment processes. (Author's abstract) W91-10883

#### DELAY IN LAKE RECOVERY CAUSED BY IN-TERNAL LOADING.

Environment Institute, JRC Ispra, 21020 Ispra, Varese, Italy. For primary bibliographic entry see Field 2H. W91-10886

DYNAMIC SIMULATION OF STORM TANKS, Laval Univ., Quebec. Dept. of Civil Engineering. For primary bibliographic entry see Field 5D. W91-10928

COMPARISON BETWEEN MODEL SIMULA-TIONS AND FIELD RESULTS FOR IN-SITU BIORESTORATION OF CHLORINATED ALI-PHATICS: PART 1. BIOSTIMULATION OF METHANOTROPHIC BACTERIA.

METHANOTROPHIC BACTERIA.
Stanford Univ., CA. Dept. of Civil Engineering.
L. Semprini, and P. L. McCarty.
Ground Water GRWAAP, Vol. 29, No. 3, p 365-374, May/June 1991. If fig. 4 tab, 33 ref. U.S.
Environmental Protection Agency Assistance
Agreement CR-81/270

Descriptors: \*Bioremediation, \*In situ treatment, \*Methane bacteria, \*Microbiological studies, \*Model studies, \*Water pollution treatment, Aliphatic hydrocarbons, Chlorinated hydrocarbons, Dissolved oxygen, Methane, Porous media.

In-situ biological methods offer promise for restorin-stu biological methods offer promise for restor-ing aquifers contaminated by organics; however, the acceptance of in-situ biological restoration methods is highly dependent on the ability to reli-ably predict the efficiency of the treatment proc-ess. A nonsteady-state model has been developed ess. À nonsteady-state model has been developed for the in-situ biostimulation of a microbial population in saturated porous media. The model includes basic processes of microbial growth, utilization of electron donor and acceptor, advective transport, dispersion, and sorption in porous media. Model simulations were compared with results from a series of controlled field experiments at a site where the growth of an indigenous population of methane-utilizing bacteria (methanotrophs) was stimulated by the controlled addition of dissolved methane and oxygen (DO) into a semiconfined aquifer. Simulations provide good matches to the mentane and oxygen (Do) into a semiconined aquifer. Simulations provide good matches to the observed transient uptake of methane and DO, demonstrating that the observed response resulted from the growth of methanotrophs in the test zone. Simulations duplicate results from alternate pulsed addition of methane (electron donor) and oxygen addition of methane (electron donor) and oxygen (electron acceptor) used as a means for distributing microbial growth throughout the test zone. The model permits estimation of changes in microbial population distribution at various stages of the two-year experiment. Temporal changes in modelistlet distribution at various stages of the two-year experiment. Temporal changes in modelisted hieractic parameters indicate that the microbial population evolved to one that more effectively utilized the methane at lower concentrations. These analyses demonstrate that a relatively simple model, which includes basic microbial and transport processes, can be of use in the design and evaluation of in-situ biotreatment processes. The model user, however, must provide judgement in the selection of appropriate input parameters, as well as being aware of model limitations. (Author's abstract) abstract) W91-10955

# GREAT LAKES TOTAL PHOSPHORUS MODEL: POST AUDIT AND REGIONALIZED SENSITIVITY ANALYSIS. Argonne. National Lab., IL. Environmental Re-

For primary bibliographic entry see Field 2H. W91-10974

INTERNATIONAL AND TRANSBOUNDARY WATER RESOURCES ISSUES.
For primary bibliographic entry see Field 6E.

CRITICAL AREA PROGRAM OF MARYLAND: IS IT CLEANING UP THE CHESAPEAKE BAY. Chesapeake Bay Critical Area Commission, An-napolis, MD.

For primary bibliographic entry see Field 6B. W91-11006

INTERSTATE COOPERATION IN DEALING WITH GROWTH RELATED WATER QUALITY IMPACTS ON THE CHESAPEAKE BAY. Rogers, Golden and Halpern, Inc., Philadelphia, PA.

For primary bibliographic entry see Field 6E. W91-11009

SUCCESSES AND CHALLENGES IN DEVELOPING AND IMPLEMENTING REMEDIAL ACTION PLANS TO RESTORE DEGRADED AREAS OF THE GREAT LAKES.

AREAS OF THE GREAT LAKES. International Joint Commission-United States and Canada, Windsor (Ontario). For primary bibliographic entry see Field 6A. W91-11030

SOCIO-ECONOMIC CONSIDERATIONS IN REMEDIAL ACTION PLANNING FOR THE GREAT LAKES-A CASE STUDY FOR SUSTAINABLE DEVELOPMENT.
Canada Centre for Inland Waters, Burlington (On-

For primary bibliographic entry see Field 6A. W91-11031

## ECONOMIC ASSESSMENT OF THE WATER QUALITY BENEFITS OF CONSERVATION TILLAGE ON SOUTHWESTERN ONTARIO CROPLAND.

Guelph Univ. (Ontario). Dept. of Agricultural Ec-For primary bibliographic entry see Field 3F. W91-11050

MICRO-TARGETING CROPLAND RETIRE-MENT FOR WATER QUALITY IMPROVE-MENT: MEASURING THE BENEFITS OF IN-CREASED INFORMATION.

Minnesota Univ., St. Paul. Dept. of Agricultural and Applied Economics. For primary bibliographic entry see Field 3F. W91-11052

## WILLINGNESS-TO-PAY FOR PROTECTION OF WATER SUPPLIES IN FOUR MASSACHU-SETTS' TOWNS.

New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Economics. For primary bibliographic entry see Field 6C. W91-11056

## SOCIAL AND PRIVATE RETURNS FROM WETLAND PRESERVATION.

Guelph Univ. (Ontario). Dept. of Agricultural Ec-

Guelph Univ. (Ontario). Dept. of Agricultural Economics and Business.

M. Van Vuuren, and P. Roy.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 553-563, 3 to h 1 ref.

Descriptors: \*Environmental protection, \*Land use, \*Ontario, \*Wetlands, Agriculture, Cost-benefit analysis, Economic aspects, Social aspects, Water quality.

Wetlands in southern Ontario are threatened by competition from urban development and agriculture. Using a case study, the economics of wetland preservation in one of the most productive agricultural areas in Canada, which is close to urban centers, is examined. Two kinds of analyses were performed: social and private cost-benefit analyses. The social analysis incorporates benefits and costs to society at large, while the private analysis includes only benefits and costs to the owner of the wetland. There is a great discrepancy between private and social net benefits of wetland preservation. From the point of view of all beneficiaries of tion. From the point of view of all beneficiaries of a wetland, preservation is the better option, par-ticularly for undiked marshes. It appears that the social preservation benefits on a 150 ha diked

## Water Quality Control—Group 5G

marsh does not match the social agricultural benefits. However, this result must be interpreted with great caution. It is most likely that if option value and water purification benefits could be included in the analysis, they would tip the balance in favor of preservation. On the 20 ha diked and 300 ha of preservation. On the 20 ha diked and 300 ha undiked marshes the preservation benefits, excluding option value and water purification benefits, are already large enough to favor preservation. From the wetland owner's point of view, the situation appears quite different. Although preservation does not result in an absolute loss, the owner is much better off reclaiming the wetlands for agriculture. The major reason for this discrepancy is that a great deal of preservation benefits cannot be cantured by the owner. Drainage subsidies and the that a great deal of preservation benefits cannot be captured by the owner. Drainage subsidies and the tax rebate program are other stimuli for reclamation. Since 1986, the full property taxes paid on farmland are rebated by the Province. Recently, a new program has been announced to rebate the taxes on wetlands as well. However, this is not sufficient to tip the balance, as can be seen in this case study. The present value of property taxes over 50 yrs on diked marshes is \$859/ha and on undiked marshes \$623/ha. More innovative approaches are needed to preserve significant existing wetlands. (See also W91-11003) (Lantz-PTT)

## EVALUATING THE IMPACT OF WATER QUALITY UPON THE VALUE OF RECREATIONAL FISHING.

Guelph Univ. (Ontario). Dept. of Agricultural Economics and Business

For primary bibliographic entry see Field 6G. W91-11058

#### MANAGEMENT OF IRRIGATION-INDUCED CONTAMINANTS.

Department of the Interior, Washington, DC. Office of Environmental Affairs.

In: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 617-626, 4

Descriptors: \*Ecological effects, \*Irrigation effects, \*Kesterson Reservoir, \*Selenium, \*Water pollution control, Fish, Pesticides, Public health, Sediment contamination, Water quality.

During the last several years there has been in-creasing recognition of the impacts of irrigation drainage water on human health and fish and wild-life resources. In 1983, the U.S. Department of the Interior discovered that elevated levels of selenium in the Kesterson Reservoir in California were caus-ing waterfowl deaths, deformities, and reproduc-tive failures. In other areas, high levels of other trace elements and pesticides have been identified subsequently in water, sediment, plant and animal samples. In response to this situation, the Interior Department initiated the National Irrigation Water Quality Program to identify, evaluate and respond Quality Program to identify, evaluate and respond to irrigation-induced contamination problems in the western United States. Results of recent work has yielded generic knowledge gained collectively from all of the investigations that are relevant to the management of irrigation-induced contaminants. These observations are: (1) that knowledge of geologic sources of trace elements is very important in determining where problems with irrigation induced contamination are likely to exist; (2) meteorological characteristics of an area can be preteorological characteristics of an area can be tion induced contamination are likely to exist; (2) meteorological characteristics of an area can be very meaningful regarding potential for irrigation-induced contamination problems; (3) closed watersheds were found to be an important physical characteristic of locations that may tend to exhibit symptoms of irrigation-induced contamination; (4) at the study areas where concentrations of seleniat the study areas where concentrations of seleni-um were found to be at levels that could adversely affect wildlife reproduction and growth (Kendrick Reclamation Project, Middle Green River, and Tulare Lake study areas), extensive irrigation and drainage activities occur; (5) selenium is the con-stituent of concern most commonly found at ele-vated concentrations in wetland ecological systems receiving irrigated drainage water; (6) concentra-tions of analytes were found to vary widely on a

### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

## Group 5G-Water Quality Control

spatial basis in all environmental media sampled; spatial dass in all environmental means sampled; (7) yearly variations in precipitation and stream-flow make accurate assessments of conditions in a given area difficult without a long period of analy-sis; and (8) that little quantitative information on pesticide applications was obtained during recon-naissance investigations. No single drainage option is likely to solve the drainage contamination prob-lems in any area. Instead, combinations of complementary options are required to control such prob-lems at acceptable levels. (See also W91-11003)

DESIGN OF ECONOMIC AND EFFICIENT TREATMENT STATION FOR ACIDIC STREAMS.

West Virginia Univ., Morgantown. Dept. of Mechanical and Aerospace Engineering. H. T. Gencsoy, J. G. Pappajohn, G. A. Clites, and

P. E. Zurbach. Pr. D. Zuroucn.

In: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemisphere Publishing Corporation, New York. 1990. p 165-174. 7 fig. 4 ref.

Descriptors: \*Acid streams, \*Hydrogen ion concentration, \*Limestone, \*Neutralization, \*Water pollution control, \*Water pollution treatment, Acidic water, Design criteria, Economic aspects, Water chemistry, Water use efficiency, West Virginia

Recent investigations have shown that crushed limestone can be used effectively and most eco-nomically to neutralize acidic streams. A treatment station for acidic streams is designed using a selffeeding rotary limestone tumbling drum activated by the stream flow. The main features included a oy the stream flow. The main features included a storage bin and hopper, a feeding mechanism, and some means of metering and transporting the lime-stone aggregates from the storage unit to the tum-bling drum. The station can operate unattended for seven to ten days while being supplied continuous-ly at the required rate from a storage bin. In a pilot treatment station at Otter Creek, West Virginia, such a system was found to be 600% more effective than the batch-loaded drum while requiring tive than the batch-loaded drum while requiring only one-sixth of the water flow requirements. The proper design of the tumbling drum requires careful consideration of certain parameters: the rate of flow and acid level of the stream, the aggregate feed rate and size, and the RPM of the drum. (See also W91-11066) (Brunone-PTT)

ENVIRONMENTAL CONTROL IMPACTS OF SELECTED ALTERNATE FUELS ON EXIST-ING POWER PLANTS.

Stearns-Roger Engineering Co., Denver, CO. E. W. Stenby, W. W. Hoskins, and A. M.

Donaldson, IN: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemi-sphere Publishing Corporation, New York. 1990. p 207-231. 10 fig, 20 ref.

Descriptors: \*Emissions control, \*Energy sources, \*Environmental protection, \*Fuel, \*Future planing, \*Powerplants, Economic aspects, Environmental policy, Hydrocarbons, Natural gas, Peat, Resources management.

Many existing utility boilers were designed to burn oil or natural gases as their primary fuel. Legislative pressures and the increasing cost of oil and natural gas, however, have forced the utility industry to consider alternates to meet the future fuel provisional of these boilers. A number of new requirements of these boilers. A number of new energy technologies and synthetic fuels have been developed in the past few years, which can be adapted to existing utility boilers. Medium Btu gas is a clean alternate fuel which can be utilized at an existing station with little impact on the boiler, is based totally on coal, an abundant US resource not subject to cutoff by overseas conflict. Waste water systems sources include coal pile rainwater runoff, cooling tower blowdown, process waste water, and raw water treatment waste water. Physical, chemical and biological phases are all needed to clean this water. Favorable economics are only

realized when the retrofit is for a large base loaded realized when the retrofit is for a large base loaded power plant and oil escalation rates are above about 7% percent. In contrast, coal-oil mixture (COM) can be used in both large and small boilers with much less substantial capital investments. However, compared to medium Btu gas, COM will have a greater impact on the boiler and ancillaries. The major impacts of COM firing on the power plant water system are increased demineralizer capacity, and additional makeup water required. In addition, COM can only replace about 40% of the oil burned and therefore can only be an interim solution to reducing oil use. Wood and 40% of the oil burned and therefore can only be an interim solution to reducing oil use. Wood and peat's water content and/or low bulk density would generally preclude hauling over the long distances required to reach many existing boilers. (See also W91-11066) (Brunone-PTT) W91-11078

UTILITY PLANNING MODEL FOR THE STUDY OF AIR POLLUTION REDUCTION, Carnegie-Mellon Univ., Pittsburgh, PA. Center for Energy and Environmental Studies.

N. 19te. In: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemi-sphere Publishing Corporation, New York. 1990. p 251-266. 7 tab, 29 ref. US EPA Assistance Agreement No. CR-808514.

Descriptors: \*Acid rain, \*Air pollution, \*Air pollution control, \*Aquatic organisms, \*Mathematical models, \*Model studies, \*Path of pollutants, \*Suspended solids, \*Utilities, Cost analysis, Economic aspects, Future planning, Sulfuric acid.

The emission of pollutants like SO2, NOx, suspended particulates, from electric utility sources, contributes to acid rain, which is considered harmful to fresh water life and crops. Some proposals for reduction of acid rain require limits to be placed on total air pollution from utilities in re-gions that have collections of plants. At present, most regulations only apply to individual plants, and thus existing models cannot predict the impact of regional emission constraints. The Advanced Simulation Model (AUSM) is an annually Utility Simulation Model (AUSM) is an annually recursive simulation model, which can provide detailed unit-specific or plant-specific results. The AUSM, however, has certain drawbacks which make using the model difficult for the study of long-term and multi-region policy issues. A linear programming model, EPOS, was developed for long-range utility planning under regional emission constraints. The model incorporates air pollution reduction strategies like using low sulfur fuel, least emissions dispatching, and pollution control technology hardware installation and operation. Using this optimization model at regional and/or national level together with the more detailed plant level this optimization model at regional and/or national level together with the more detailed plant level annually recursive model, impacts of regional pollution reduction policies on various social and economic parameters like cost of electricity, pattern of electricity usage, etc. (See also W91-11066) (Author's abstract)

MATHEMATICAL MODELLING FOR SUL-PHUR DIOXIDE REMOVAL FROM STACK GASES IN A FLUIDIZED BED OF ACTIVATED SODIUM CARBONATE.

National Research Centre, Cairo (Egypt). Pilot

H. El Abd. and G. El Diwani.

IN: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemi-sphere Publishing Corporation, New York. 1990. p 267-276. 5 fig. 2 tab, 7 ref.

Descriptors: \*Air pollution control, \*Emissions control, \*Fluidized bed process, \*Mathematical models, \*Model studies, \*Sodium carbonate, \*Sulfur dioxide, Effluents, Kinetics, Model testing, Path of pollutants, Water pollution control

The presence of sulfur oxides in stack gases leads The presence of sulfur oxides in stack gases leads to one of the greatest pollution problems today. Control of sulfur dioxide emissions through absorption by a fluidized bed of activated carbonate proved to be not only a feasible process but also to have many advantages over other known processes. A mathematical model describing the overall kinetics of the process was developed, with kinetic parameters evaluated at different reaction temperatures based on integral fluidized bed reactor data. The operating conditions of the experiment were adjusted to simulate the actual conditions found in stack effluents. Therefore, data obtained can be used with a good degree of accuracy, in the design of fluidized bed reactors, for stack gas treatment under similar flow behavior. A high degree of sulfurization (over 95%) is achieved. (See also W91-11080) W91-11080

OIL TRANSPORT MANAGEMENT AND MARINE POLLUTION CONTROL: OIL SPILL PREVENTION.

Rutgers - The State Univ., Piscataway, NJ.

Ruigers - Ine State Only, Facataway, 193.

E. L. Bourodimos, and C. C. Carvounis.

IN: Environmental Problems and Solutions:
Greenhouse Effect, Acid Rain, Pollution. Hemisphere Publishing Corporation, New York. 1990. p.
399-411. 2 fig, 27 ref.

Descriptors: \*Environmental protection, \*Marine pollution, \*Oil pollution, \*Oil spills, \*Water pollution control, Administrative agencies, Ecological effects, Economic growth, Industrial development, Oil slicks, Transportation, Water pollution preven-

The exponential increase of crude oil sea and land The exponential increase of crude oil sea and land transport over the last twenty years is the result of an economic expansion and industrial growth on a global scale, especially of the developed and developing countries. The significant threat to the ocean, coastal and estuarine ecosystem stability and ecological diversity because of the oil spills and slicks is a major problem. Oil spills in the marine environment may have reached up to six million metric tons, with about 44% of oil spills resulting from land sources and refineries, 35% ship generated, 10% from natural seepage, and 10% from atmospheric fallout. No single solution exists. The Mediterranean, Caribbean, Baltic, and North Seas and the Arctic region face different oil exists. The mediterranean, Caribocan, battic, and North Seas and the Arctic region face different oil spill and oil pollution problems. Accordingly, a many-sided institutional approach and regional marine pollution control planning, management and agencies are needed to achieve the most effective oil spill prevention. Proper oil transport technicel coordination and management is aimed at energy conservation, which is an excellent environmental quality and protection methodology and planning strategy. (See also W91-11066) (Brunone-PTT) W91-11081

ANALYSIS OF GROUND-WATER FLOW IN THE A-SAND AQUIFER AT PARAMARIBO, SURINAME, SOUTH AMERICA.

Geological Survey, Tallahassee, FL. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-11090

BEHAVIOR OF DOUBLE GEONET DRAIN-AGE SYSTEMS.

Drexel Univ., Philadelphia, PA. Geosynthetic Research Inst.

For primary bibliographic entry see Field 5A. W91-11096

METHODOLOGY TO DERIVE WATER-QUALITY TRENDS FOR USE BY THE NATIONAL WATER SUMMARY PROGRAM OF THE U.S. GEOLOGICAL SURVEY.

Geological Survey, Reston, VA. Water Resources

For primary bibliographic entry see Field 7B.

BAN ON PHOSPHORUS IN DETERGENTS: THE EFFECTS ON THE PHOSPHORUS CON-TENTS OF SWISS SEWAGE SLUDGES AND ON THE EFFICIENCY OF PHOSPHORUS

## Water Quality Control-Group 5G

ELIMINATION BY SEWAGE TREATMENT PLANTS.

Eidgenoessische Forschungsanstalt fuer Agrikul-turchemie und Umwelthygiene, Bern (Switzerland).

nary bibliographic entry see Field 5D.

AGRICHEMICALS AND GROUNDWATER PROTECTION: RESOURCES AND STRATE-GIES FOR STATE AND LOCAL MANAGE-

MENT.
Proceedings of a Conference held October 24-25, 1988, St. Paul, Minnesota. Freshwater Foundation, Navarre, Minnesota. 1989. 416p.

Descriptors: \*Agricultural chemicals, \*Conferences, \*Groundwater quality, \*Nonpoint pollution sources, \*Path of pollutants, \*Water pollution consources, \*Path of pollutants, \*Water pollution con-trol, \*Water quality management, Agricultural practices, Education, Groundwater pollution, In-formation transfer, Pesticides.

This conference focusing on agrichemicals and groundwater, brought together people from 26 states and Canada. Because fertilizer use has quadrupled between the years 1960-1980 and pesticide use has tripled since 1964, it poses a hazard to groundwater, the source of drinking water for nearly half of the United States and for 97% of its rural population. To date, at least 17 pesticides have been found in groundwater in 23 states, and nitrates have been found in 20% of wells tested throughout the country. The conference highlightintrates have ocen found in 20% of wells teach throughout the country. The conference highlight-ed and analyzed usable, practical information re-sources and model programs presently in place and available to assist states, local entities, and farmers available to assist states, local entities, and armiers in balancing agrichemical use and groundwater protection more effectively. The Geological Survey, Department of Agriculture, Environmental Protection Agency, individual states, local entities, industry, and non-profit organizations described initiatives in information systems, funding, sweets diseased education and training. (See Wollwaste disposal, education and training. (See W91-11163 thru W91-11205) (Rubinstein-PTT) W91-11162

AGRICHEMICALS AND GROUND WATER: ASSUMPTIONS ABOUT FARMER INFORMA-TION PROCESSES.

Wisconsin Univ.-Madison. Dept. of Soil Science. For primary bibliographic entry see Field 6B. W91-11163

COMMUNICATING WITH FARMERS: PRO-VIDING USEFUL AND RELIABLE SOURCES OF INFORMATION.

C. K. Constant.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 37-54, 6 fig, 2 tab, 6 ref.

Descriptors: \*Agricultural chemicals, \*Agricultural practices, \*Groundwater quality, \*Information transfer, \*Nonpoint pollution sources, \*Surveys, \*Water pollution control, Decision making, Farm management, Fertilizers, Groundwater pollution, Pesticides, Tillage, Water quality control.

A survey was conducted of farm operators in Iowa in 1987 to determine: (1) the present pattern of use of sources of information for those crop production operations most related to agricultural chemical use; and (2) the perceived reliability of these information sources. These sources represented mass media, government agencies, personal or peer experience, non-norfic to granizations, and private mass media, government agencies, personal or peer experience, non-profit organizations, and private sector entities. Three aspects of crop production were examined: tillage practices, fertilizer application, and pesticide application. Questionnaires were sent to 360 farmers and 89 valid responses were received. For tillage practices, 94% of the respondents considered their own experience as the spondents considered their own experience as the primary source. Fertilizer application information indicated that although many cited their own experience, local sales dealers were used by 60% and preferred by nearly 25%. Additional sources, in-cluding crop consultants, Extension Service, and farm publications were used by more than 25%. Of

these, consultants and Extension Service were pre-ferred by over 10%. Preferred information sources ferred by over 10%. Preferred information sources for pesticides indicated a need to augment personal experience with outside sources. Sales dealers were cited as most preferred by 30%, with personal experience a close second at 28%. Other preferred sources were manufacturer representatives and crop consultants. Reliability estimates were based to a combination of the presentation of the presentation of the presentation. on a combination of the perception of the source's bias and the validity of the information it disseminates. The Soil Conservation Service was considered to be most reliable followed by the Extension Service. Chemical company representatives were considered to be the least reliable. Therefore, it appears that no one source provides trusted, unbiased, applied, personalized, and knowledgeable advice to farmers to persuade them to reduce their chemical inputs. To be effective, public programs dealing with groundwater protection will have to motivate farmers to seek out new knowledge. advice from new and existing sources that they trust and find useful. (See also W91-11162) (Rubin-

EMERGING ISSUES AT THE INTERSECTION OF AGRICULTURAL AND ENVIRONMENTAL POLICY.

G. Torres.
IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 55-58.

Descriptors: \*Agricultural chemicals, \*Ground-water quality, \*Information transfer, \*Nonpoint pollution sources, \*Surveys, \*Water pollution con-trol, Agricultural practices, Attitudes, Decision making, Farm management, Groundwater pollu-tion, Herbicides, Pesticides, Water quality control.

Farmers were interviewed in five watershed areas in different parts of the country to ascertain their attitudes about groundwater contamination and possible solutions. An additional goal was deter-mine sources of farmers' information and the effect on beliefs and attitudes. The farmers' preference as a source for pesticide and herbicide information was: Cooperative Extension Service > chemical manufacturers and dealers > Soil Conservation Service. Nearly 90% of the farmers believed that Service. Nearly 90% of the farmers believed that free technical advice would help reduce their dependence on herbicides and pesticides. More than 75% would be willing to rotate crops, so long as their commodity base could be protected. A substantial minority considered groundwater to be their property to use and treat as they see fit. This attitude could generate resistance to future legislation. (See also W91-11162) (Rubinstein-PTT) W91-11165

NATIONAL PROGRAM FOR SOIL AND WATER CONSERVATION, ITS EFFECT ON

For primary bibliographic entry see Field 3F. W91-11169

SOIL CONSERVATION SERVICE AND EX-TENSION: COOPERATING TO ENHANCE SERVICES (MES PORTION).

For primary bibliographic entry see Field 6E. W91-11170

WELLHEAD PROTECTION-INFORMATION AND RESOURCES. S. P. Roy. IN: Agrichemicals and Groundwater Protection:

Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 135-143, 1 fig, 2 tab.

Descriptors: \*Groundwater quality, \*Nonpoint pollution sources, \*Water quality control, \*Wells, Agricultural chemicals, Information exchange, Information transfer, Management planning, Training, Water quality, Wellhead protection.

Many states are moving forward with innovative legislation to address various aspects of the agri-

chemical/groundwater issue. The Wellhead Protection program provides a framework for state agencies to consider agricultural impacts on groundwater quality and to develop and implement groundwater protection programs. As a resource to assist state and local governments to develop and implement programs to address agrichemicals and groundwater protection, the Environmental Protection Agency (EPA) has Groundwater Representatives in each of its ten regional offices. These individuals and their staffs are available to assist state and local officials in all areas of groundwater protection. (See also W91-11162) (Korn-PTT) W91-11172 W91-11172

CROP DATA MANAGEMENT SYSTEMS, INC. MEETING CALIFORNIA'S PESTICIDE REGULATION CHALLENGE.

R. A. Krause.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 175-179.

Descriptors: \*Agricultural practices, \*California, \*Computer programs, \*Databases, \*Nonpoint pollution sources, \*Pesticides, \*Water pollution contol, Agricultural chemicals, Compliance, Groundwater contamination, Legislation, Regulations, Water quality.

In response to California's agricultural and environmental regulations and legislation, agrichemical manufacturers, formulators, distributors, retailers, advisors (salespeople), and farmers have developed a need for an efficient method of insuring the proper use of agrichemicals. Crop Data Management Systems, Inc. (CDMS) from Marysville, CA ment systems, inc. (CDMs) from Marysville, CA
has developed a computerized pesticide recommendation writing system called the Advanced
Consultant Service (ACS). ACS provides automatic checking of the proposed pesticide usage against
a Product Label Data Base supplied by the product manufacturers and against the current state and uct manufacturers and against the current state and federal regulations governing the use and recommendation of the product. CDMS has also developed a label referencing system called the Agricultural Pesticide Label Service (APLS) for those states where written pesticide use recommendations are not required. APLS allows rapid searching of the Product Label Data Base for all products that meet sixtem existence APLS will then grief. ucts that meet given criteria. APLS will then print concise information on the particular use of the product requested. APLS also contains the MSDS information for the product in the data base. (See also W91-11162) (Korn-PTT) W91-11177

FUNDING GROUNDWATER PROTECTION PROGRAMS: IOWA'S GROUNDWATER PROTECTION FUND.

Iowa Dept. of Environmental Quality, Des Moines.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 203-206.

Descriptors: \*Administrative agencies, \*Funding, \*Groundwater resources, \*Local governments, \*Nonpoint pollution sources, \*Water pollution control, Agriculture, Hazardous wastes, Oil industry, Solid wastes, Storage tanks, Underground storage.

The Iowa Groundwater Protection Act, and its associated funding structure, has received a lot of attention in recent years. The Act is based on the 1987 Iowa Groundwater Protection Strategy. The Strategy did not make specific recommenda The low Groundwater Programs might be funded. The low Groundwater Protection Act was originally projected to raise somewhere around 38 milion dollars in revenue in its first five years. In addition, it allocates 17.5 million dollars of the state's oil-overcharge funds to energy related por-tions of the Iowa's program. The actual revenues for the first year were slightly lower than antici-

### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

## Group 5G-Water Quality Control

pated. However, the revenues have been increasing and are expected to come close to meeting the original projections by this time next year. The Act establishes an Iowa Groundwater Protection Fund, and within the fund five accounts. These accounts include a Solid Waste Account, a Household Hazardous Waste Account, a Storage Tank Management Account, and an Agricultural Management Account. The Act spells out in detail how money is to be generated as well as how it is to be spent. The generated as well as how it is to be spent. The accounts are program specific. That is to say, the accounts are program specific. Intal is only, the money generated in a program area can only be spent on solving the problems associated with that program. In addition, the accounts act as revolving fund accounts and, with the exception of oil over-charge funds, carry-over from year to year. (See also W91-1162) (Korn-PTT)

MINNESOTA CLEAN WATER PARTNERSHIP

Minnesota Pollution Control Agency, Roseville.

Minnesota Poliution Control Agency, Roseville. W. P. Anderson. IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 213-217.

Descriptors: \*Minnesota, \*Nonpoint pollution sources, \*Water quality control, \*Water resources management, Administrative agencies, Cost sharing, Economic aspects, Governmental interrelations, Local governments.

Recent evidence indicates that nonpoint source (NPS) pollutants entering surface and groundwaters in runoff and seepage from land areas affects ers in runon and seepage from and actas ancers most of Minnesota's water resources, and current programs are unable to deal adequately with the problem. In response to this, the Minnesota Legislature enacted the Clean Water Partnership (CWP) in 1987. The purpose of the CWP is to provide interested local units of governments with reinterested tocal units of governments with re-sources to establish water quality projects designed to protect and improve the water quality of lakes, streams, and groundwater affected by NPS pollu-tion. These resources are in the form of 50-50 matching grants, and technical assistance from the Minnesota Pollution Control Agency (MPCA) and other state agencies. It is the sharing of project development and implementation responsibility that characterizes the partnership between state that characterizes the partnership between state agencies and local governments in controlling NPS pollution. The partnership is formulated to provide flexible solutions to unique local problems through a diagnostic study, implementation plan, and an implementation project. However, the CWP is a diagnostic study, implementation pian, and an implementation project. However, the CWP is supported by limited state funds. Grant applications are reviewed by the MPCA and awarded points based on specific criteria. Those water quality projects with the most points would be eligible to receive the grants first. A project coordination team made up of up to thirteen federal and state agencies, the University of Minnesota, and local agencies, the University of Minnesota, and local government representatives will assist the MPCA in project evaluation and selection as well as pro-vide coordinative and technical support to the projects. (See also W91-11162) (Korn-PTT) W91-11181

WELLHEAD PROTECTION IN MASSACHU-SETTS: PROTECTING PUBLIC WATER SUP-PLIES FROM PESTICIDE IMPACTS. Massachusetts Div. of Water Supply, Boston

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Man-agement. Freshwater Foundation, Navarre, Minnesota, 1989. p 221-237, 2 fig.

water quality, "Massachusetts, "Nonpoint pollution, ources, "Pesticides, "Public waters, "Water quality control, "Water supply, "Wells, Administrative agencies, Environmental impact, Geographic information systems, Land use, Recharge basins. Descriptors: \*Groundwater pollution. \*Ground-

The Massachusetts Department of Environmental Quality Engineering, Division of Water Supply

conducts an active program to protect the quality of public supply wells and groundwater. A key element of this program is the control of land uses which may adversely affect groundwater quality. The State's approach emphasizes protection of the recharge area of public supply wells, achieved through definition and delineation of protection zones around the well. By applying the same prozones around the well. By applying the same pro-tection area, definition to programs of more than one state agency, and at both the local and state level, a synergy has been achieved that has permit-ted much to be done even with limited staff and funding. (See also W91-11162) (Author's abstract) W91-11182

WISCONSIN'S RISK ASSESSMENT BASED NUMERICAL GROUNDWATER STANDARDS

PROGRAM.
Wisconsin Div. of Health, Madison. Section of Environmental and Chronic Disease Epidemiolo-

D. A. Belluck, and H. A. Anderson.

D. A. Belluck, and H. A. Anderson.
In: Agrichemicals and Groundwater Protection:
Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 239-253, 2 tab, append.

Descriptors: \*Administrative agencies, \*Ground-water pollution, \*Nonpoint pollution sources, \*Risk assessment, \*Water law, \*Water quality standards, \*Wisconsin, Data requirements, Inter-agency cooperation, Monitoring, Pesticides, State jurisdiction, Toxicology.

Goundwater contaminant monitoring programs throughout the United States are revealing wide-spread groundwater contamination by agricultural and industrial chemicals at concentrations of environmental and public health concern. The federal government's reticence to establish a national groundwater resource protection program with groundwater testure protection program with numerical enforcement standards, based on health effects toxicology data has, in many instances, forced the development of state-led programs to address pressing local needs. The Wisconsin De-partment of Health and Social Services has been active in the development of Wisconsin's ground-water standards development or corrent. Isoconsactive in the development of wisconsin s ground-water standards development program. Informa-tion regarding pesticide environmental fate and toxicology issue are needed if the states are to successfully implement the U. S. Environmental Protection Agency (EPA) agrichemical strategy. The Wisconsin numerical standards program was developed through involvement in standards set-ting and performing risk assessments in communi-ties with contaminated sole source aquifers. Imple-mentation of the numerical standards based groundwater law has proceeded successfully since the passage of the act in 1984. State agency implementation of groundwater standards has resulted in the alteration of activities and practices which could result in contamination of groundwater above an enforcement standard. Agricultural prac-tices have been altered to take into account the propensity of certain agrichemicals to enter groundwater after normal agricultural use. Parties responsible for contaminating groundwater have been prosecuted and have been forced to pay damages resulting from their acts. (See also W91-11162) (Korn-PTT) W91-11183

### RURAL CLEAN WATER PROGRAM.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minneta. 1989. p 257-258

Descriptors: \*Nonpoint source pollution, \*Water pollution controls, \*Rural areas, Evaluation, Cost sharing, Water quality, Agriculture, Conservation, Management planning.

The Experimental Rural Clean Water Program (RCWP) was an experimental program developed to evaluate the effectiveness of applied best man-agement practices (BMP's) in controlling agriculture nonpoint source pollution for improved water quality. Twenty-two projects were selected and funded for implementation based on extensive plans of work desribing watersheds with seriuous plans of work destribing watersheds with serulous agricultural nonpoint source pollution problems, documenting water use impariments and outlining best management practices to be applied to help reduce the problems and improve water quality. Full scale, multilevel water quality monitoring programs were implemented to determine the effects of applied conservation on water quality in surface of applied conservation on water quality in surface and groundwater resources in these project areas. The RCWP uses the concept of long-term contracts as the basis for cost sharing participants. Long-term contracts require a participant to carry out elements of a conservation plan over a specified number of years. Cost share funds are available to help install selected BMP's on critical acres. The conservation plan became the cornerstone of the program. It identified those conservation practices needed to reduce or eliminate resource prob-lems that would lead to water quality degradation or water use impairment. RCWP was the first program in which Soil Conservation Service (SCS) developed water quality conservation service (SCS) developed water quality conservation plans aimed directly at reducing agricultural nonpoint source pollution. (Korn-PTT).

W91-11184

RED RIVER BASIN GRASS ROOTS POLICY PROCESS.

For primary bibliographic entry see Field 6B.

INNOVATIVE SUBSURFACE SEWAGE MAN-AGEMENT: A PROGRAM TO PROTECT IDAHO'S RATHDRUM PRAIRIE AQUIFER.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 265-268.

Descriptors: \*Groundwater pollution, \*Groundwater recharge, \*Idaho, \*Nonpoint pollution sources, \*Septic tanks, \*Septic wastewater, \*Water quality control, Land development, Regulations.

Idaho's Panhandle Health District (PHD) has created an innovative program for protecting the quality of drinking water withdrawn from the Rathdrum Prairie Aquifer-designated a sole source aquifer by the U. S. Environmental Protecsource adapter by the continuous at the recharge of septic tank effluent to the aquifer. To achieve this goal, the PHD has used a combination of broad policies that encourage sound environmental practices, general regulations that effectively limit residential sprawl and development in rural areas in the District and specific civil contracts called sewage management agreements (SMAs) that govern the trict and specific civil contracts called sewage management agreements (SMAs) that govern the permitting of septic tanks inside municipalities in the District. The program's policies-especially sewage management agreements-have succeeded in directing the recharge of wastewater effluent, thereby helping to protect a unique and valuable natural resource. (See also W91-11162) (Korn-W91-11186

MINNESOTA'S OLMSTED COUNTY: A COOP-ERATIVE HEALTH BASED PERSPECTIVE ON ZONING AND PLANNING.

Olmsted County Health Dept., Rochester, MN. Div. of Environmental Health. For primary bibliographic entry see Field 6B.

NORTHWEST KANSAS GROUNDWATER MANAGEMENT DISTRICT NO. 4, AN ABAN-DONED WELL PROGRAM. W. A. Bossert.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 279-289.

Descriptors: \*Abandoned wells, \*Groundwater management, \*Groundwater pollution, \*Kansas, \*Nonpoint pollution sources, \*Water pollution pre-

## Water Quality Control—Group 5G

vention, Costs, Education, Regulations, State jurisdiction

By 1986 the Northwest Kansas Groundwater Management District No. 4 board decided it wanted to address the issue of abandoned wells as ground-water contamination threats. The district's man-agement program now had to deal with traditional water quantity issues as well as water quality issues. The district board decided that its approach to water quality would be committed primarily protection and prevention issues. The organizati protection and prevention issues. The organization of the management program requires that a problem be identified; then a program is designed to address the problem. If the program needs implementation or enforcement authority, a policy, resolution or regulation is then passed. Since the management program is required to be reviewed and either modified or re-adopted annually, this proc-ess remains timely and responsive for the district's needs as these needs change and/or evolve. Each needs as these needs change and/or evolve. Each management program goes through state adoption and local public hearing prior to implementation. Of all the wells located and initiated into the system, approximately 80% have responded to the district's initial notification letter. Overall, the abandoned well program has addressed many wells which would not have otherwise been dealt with. (See also W91-11162) (Korn-PTT) W91-11188

CENTRAL PLATTE NATURAL RESOURCES DISTRICT'S GROUNDWATER MANAGE-MENT PROGRAM.
Central Platte Natural Resources District, Grand

M. Moravek

M. Moravek.

IN: Agrichemicals and Groundwater Protection:
Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 301-304.

Descriptors: \*Groundwater management, \*Groundwater pollution, \*Nebraska, \*Nitrates, \*Nonpoint pollution sources, \*Water pollution control. Administrative agencies, Fertilizers, control, Administrative agencies, Fertilizers Leaching, Water pollution sources, Well water

The Central Platte Natural Resources District (CPNRD) covers over 2 million acres in south central Nebraska. In 1973, over 500 irrigation and domestic wells were sampled revealing high groundwater nitrate concentrations. Additional studies were conducted to determine the studies were conducted to determine the source of the nitrate contamination. It was determined that most of the nitrates in the groundwater could be directly attributed to excess commercial nitrogen fertilizers being applied to the fields. In 1979, the CPNRD initiated a project to determine ways of reducing nitrogen leaching and possibly cleaning up the already polluted groundwater by establishing test fields where district staff worked with the farmers on nitrogen applications, irrigation scheduling, and harvest. However, re-sampling in 1983 revealed that nitrate levels had increased substantially. The CPNRD has since established a Groundwater Management Plan which is based on past research carried out by the district and numerpast research carried out by the district and numer-ous state and federal agencies. It is designed not to reduce crop yields. By balancing the system and only applying the nitrogen needed, yields can be maintained and groundwater pollution reduced. The adopted program established 'Phases' based on the seriousness of the groundwater nitrate prob-lem. The more serious the problem the higher the phase. In addition, operators are required to attend education or certification classes. (See also W91-11162) (Korn-PTT) W91-11190

## RETURNABLE PESTICIDE CONTAINERS: MAINE'S DEPOSIT AND COLLECTION MAINE'S SYSTEM.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 307-310.

Descriptors: \*Hazardous waste disposal, \*Land-fills, \*Maine, \*Nonpoint pollution sources, \*Pesti-

cides, \*Regulations, \*Solid waste disposal, \*Waste disposal, \*Water pollution control, Administrative agencies, Pesticide containers, State jurisdiction.

In 1983 the state of Maine's Board of Pesticides Control (BPC) prepared legislation to require triple rinsing and return of restricted use pesticide containers made of glass, metal or plastic. The four main components of the new law are as follows: (1) all limited and restricted use pesticides contain-(1) all limited and restricted use pesticides containers, excluding those made of cardboard, fiberboard or paper, must be triple rinsed according to regulations promulgated by the BPC; (2) dealers must charge a deposit at the time of sale sufficient to ensure return of the container (by regulations, the BPC set the deposit at five dollars for anything smaller than 10 gallon drums and ten dollars for 30 gallon and larger drums); (3) all containers covered under this act must bear an alpha numeric sticker to identify the purchaser and dealer (normally this would be attached by the dealer and recorded at the time of sale); and (4) the deposit would not be would be attached by the dealer and recorded at the time of sale); and (4) the deposit would not be refunded until the container had been triple rinsed and returned to the seller or an alternate designatand returned to the sense of an atternate designation of the season collections are conducted at nineteen locations throughout the state. The return process works best when the containers can be buried in the community where containers can be buried in the community where they are inspected. Unfortunately, this only hap-pens at eight of the 19 sites so the BPC and the dealers have had to make special arrangements to get the containers transported to a commercial landfill in the center of the state. (See also W91-11162) (Korn-PTT) W91-11191

## OREGON PESTICIDE CONTAINER INITIA-

Oregon Agricultural Chemical Association, Salem. or primary bibliographic entry see Field 5E. 791-11192

MINNESOTA WASTE PESTICIDE COLLEC-TION PILOT PROJECT.

For primary bibliographic entry see Field 5E. W91-11193

## URBAN PESTICIDE WASTE MANAGEMENT: STRATEGIES FOR EDUCATION AND COL-

For primary bibliographic entry see Field 5E. W91-11194

#### PESTICIDE RINSEATE MANAGEMENT PLAN. T. Ambroz.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 343-351.

Descriptors: \*Hazardous waste disposal, \*Minnesota, \*Nonpoint pollution sources, \*Pesticides, \*Wash water, \*Waste management, \*Wastewater disposal, \*Water pollution control, Contamination, Design criteria, Economic aspects, Management planning, Monitoring, Pesticides spraying, Rainfall, Regulations, Storage tanks, Underground storage.

The Minnesota Agricultural Aircraft Association with the help of the Minnesota Technical Assistance Program (MN TAP) has developed a Pesticide Rinseate Management Plan. The project goals included the collection of pesticide rinseate and equipment washwater, the minimization of water waster and the verse of investical and washer the project of the state of the project of the state runoff, and the reuse of rinseate and washwater. The basic system consisted of a concrete slab with curbs constructed on a gravel base with a slope away from the slab. Several factors were considered in the area of system design and system man-agement. The first factor included the use of plasitc liners and/or underground monitoring systems. It was decided to forego any underground monitoring system, but cracks in the concrete must be toring system, but cracks in the concrete must be repaired promptly. A second factor involved the control of rainwater discharge. Several design and management techniques were adopted to allow management decisions based on operational differ-ences and economic considerations. Another factor

involved in the design was the management of sediment accumulation in the sump. To avoid cross contamination, sediment must be cleaned out when switching from one target crop pesticide to another. A fourth factor that was considered inother. A fourth factor that was considered involved the management of rinseate and washwater which would be collected in separate above-ground storage tanks. The final factor involved the potential classification of the sump as an underground storage tank. This issue was settled when the Minnesota Pollution Control Agency (MN PCA) declared that sumps are classified as underground storage tanks under federal regulations. (See also W91-11162) (Korn-PTT) W91-11195

## AGRISOURCE: THE INFORMATION SYSTEM FOR CROP TECHNOLOGY.

REACH/AgriSource, Cenex/Land O'Lakes, PO Box 64089, St. Paul, MN 55164-0089. For primary bibliographic entry see Field 10D. W91-11196

SOIL TEC: A COMPUTERIZED SOIL-SPECIF-IC FERTILIZER APPLICATION SYSTEM. CENEX/Land O'Lakes, St. Paul, MN 55164-0089. For primary bibliographic entry see Field 7C. W91-11197

## PROFESSIONALISM IN AGRICULTURE: SEEKING A TRAINING STANDARD.

J. A. Ladlie. IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 365-370.

Descriptors: \*Agricultural chemicals, \*Education, \*Fertilizer management, \*Information exchange, \*Information transfer, \*Nonpoint pollution sources, \*Training, Certification, Professional per-sonnel.

There is a growing realization that, as suppliers of information to growers, individuals in the agrichemical industry need to be highly qualified. The information provided to farmers must be accurate, useful, and timely. In order to respond to the demand for information, the agrichemical dealers and manufacturers' representatives need to reach a high level of knowledge and expertise. The Nehigh level of knowledge and expertise. The Ne-braska Certified Crop Production Advisor (NCCPA) Foundation, in collaboration with the Agri-Growth Company, have developed a chal-lenging program of testing and certification for agrichemical professionals. Agri-Growth provides the professional training development services and the NCCPA Foundation provides review and sponsorship. The instruction is presented in two one-week sessions, each of which culminates in a test Each of the tests must be passed with a 75%. test. Each of the tests must be passed with a 75% minimum passing score in order for the trainee to become a Certified Crop Production Advisor. Due to the success and increasing interest in the pro-gram from other states, the NCCPA has decided to move in the direction of a national program of certification. (See also W91-11162) (Korn-PTT) W91-11198

## DEVELOPING A GROUNDWATER TRAINING PROGRAM FOR PESTICIDE USERS.

P. J. Marer.

In: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 371-376.

Descriptors: \*Education, \*Groundwater management, \*Groundwater pollution, \*Hazardous materials, \*Information transfer, \*Nonpoint pollution sources, \*Pesticides, \*Training, \*Water pollution

Educating pesticide users on ways to protect groundwater from pesticide contamination is an important step in managing groundwater problems. Recognizing this need, the U. S. Department of Agriculture (USDA) and the U. S. Environmental

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

## **Group 5G—Water Quality Control**

Protection Agency (USEPA) provided funding to Cornell University and the University of California to jointly develop a training module suitable for use throughout the United States. The resulting 'Pesticides and Groundwater' educational package for pesticide users consists of a slide set, story board, instructor manual, and a set of originals for producing four pages of handout material. These are packaged in a 3-ring binder for a cost of seventy-five dollars. The module can be obtained from the New York State Water Resources Institute, Center for Environmental Research, 468 Hol-lister Hall, Cornell University, Ithaca, NY 14853. The nature of the module is such that it offers instructors the flexibility of including additional text and slides. This allows customization of the presentation to fit local needs and environmental conditions or to relate to specific audiences. It can be easily updated as conditions change. (See also W91-11162) (Korn-PTT) W91-11199

## MARYLAND'S TRAIN-THE-TRAINER PRO-GRAM HOUSEHOLD HAZARDOUS WASTE.

M. L. Sowell.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 377-383.

Descriptors: \*Drinking water, \*Education, \*Hazardous waste disposal, \*Information transfer, \*Maryland, \*Nonpoint pollution sources, \*Water pollution prevention, Domestic wastes, Groundwater management, Groundwater pollution, Training, Water resources management, Workshops.

Two counties in Maryland were selected as pilot test sites for a drinking water outreach program. The objective of the program would be to increase individual household knowledge about drinking water and how individuals' practices can affect the quality of drinking water. The Community Resource Development Agents in both counties developed a strategy for maximizing audience outreach by conducting a Train-The-Trainer Workshop. Those people interested in becoming a trainer would have to agree to train others in the community. Participants in the workshop received a number of fact sheets pertaining to household products and the disposal of these products, and information of water quality and water resources. A slide presentation was also shown to the trainers and included information on the disposal of hazardous waters. A referral and information and information on the disposal of hazardous waters. ardous waste. A referral and information fact sheet accompanied each slide. Once the training was over, the participants were ready to go out to conduct similar workshops in the communalso W91-11162) (Korn-PTT) W91-11200

## FARM BUREAU'S GROUNDWATER AND EN-VIRONMENTAL QUALITY SELF-HELP CHECKLIST FOR FARMSTEADS AND FARM

I Porterfield

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 387-392, 1 fig.

Descriptors: \*Agricultural chemicals, \*Education, Nonpoint pollution sources, Water pollution prevention, Drinking water, Environmental protection, Farm management, Farms, Groundwater pollution, Regulations, Surveys, Training, Water qual-

Voting delegates at the American Farm Bureau Federation's national annual meeting in 1986 rec-ommended that the Farm Bureau create a special ominence that the Farm bureau create a special environmental pollution task force in response to growing concern about the impact of agricultural chemicals on drinking water supplies. This special study committee noted the site specific nature of groundwater, soil types, climate and natural pollut-ants. They also recognized the need to improve ants. They are recognized the need to improve nutrient management and minimize nitrogen losses to the environment. The task force concluded that a questionnaire/checklist type program should be developed to highlight safe storage and handling of agricultural chemicals, mixing, and loading loca-tions and techniques. The development of the checklist took about one year. Each state Farm Bureau was provided with a set of camera-ready slicks which could be modified to reflect state laws and farming practices. Information on the slicks and other related services are part of a package supplied to each state Farm Bureau. The Farm Bureau's Self-Help Checklist is really a tool to raise questions and prompt farmers to search out answers and best management practices from extension and health officials. (See also W91-11162) (Korn-PTT) W91-11201

## FLORIDA'S PESTICIDE WATER QUALITY EDUCATION PROGRAM.

EDUCATION PROGRAM.
Florida Univ., Gainesville. Dept. of Soil Science.
A. G. Hornsby.
IN: Agrichemicals and Groundwater Protection:
Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 393-398, 2 fig. 1 tab.

Descriptors: \*Education, \*Florida, \*Nonpoint pol-lution sources, \*Pesticides, \*Training, \*Water pol-lution prevention, Computer programs, Fate of pollutants, Geohydrology, Soil contamination, Water pollution sources, Water quality, Water quality management quality management.

The state of Florida has developed an in-service training program entitled 'Pesticide Usage and Its Potential Impact on Surface and Groundwater Quality.' The program is conducted annually by the Florida Cooperative Extension System (CES). A multidisciplinary team of instructors are used to provide excellent resource expertise and materials provide excellent resource expertise and materials that the county extension agents can draw upon as they develop materials and programs for county use. The content of the training course consists of four principle segments which make up the core materials offered each time and two or three segments which vary depending on availability of resource persons and current issues regarding pesticide use in the state. The four principle segments include the following (1) geochytekelogy and the include the following: (1) geohydrology and the water cycle, (2) sources of contamination, (3) physical, chemical, and biological processes that con-trol pesticide fate in the environment, and (4) management practices to rescue or prevent water quality impairment. A concerted effort is made to assure that the audiences make the connection between the water resources potentially being impacted, the processes that control chemical fate nd transport in the environment, and management alternatives that can reduce or prevent these im-pacts. A manual is provided for each training session that consists of Extension fact sheets, circulars, research articles, and other available relevant materials that contribute to the understanding of the subject. In addition to the above materials, microcomputer software has been developed as a teaching tool to reinforce understanding of pesticide fate in soils. (See also W91-11162) (Korn-PTT) W91-11202

## STRATEGIES FOR NONPROFIT ORGANIZA-TIONS FOR PREVENTING AGRICHEMICAL CONTAMINATION OF GROUND WATER.

Center for Rural Affairs, Hartington, NE. Sustainable Agriculture Project.

R. Krupicka. In: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 407-410.

Descriptors: \*Agricultural chemicals, \*Nonpoint pollution sources, \*Organizations, \*Public participation, \*Water pollution prevention, Administrative agencies, Environmental protection, Farming, Water pollution, Water re-

More innovative and creative strategies are needed to address the many complex environmental, social, and economic problems associated with agricultural chemicals and groundwater quality issues. Non-profit organizations can play a role in addressing these problems by promoting change in the existing system and by innovative and creative approaches to problem solving. In addition, non-profit organizations can hold public institutions to their responsibility of seeking and implementing solutions rather than allowing them to avoid or place the responsibility elsewhere. The main public place the responsibility eisewhere. The main public institution that has provided information on various farming practices has been the land grant research and extension system. The Center for Rural Affairs, a private non-profit organization, has provoked public thought about social, economic, and environmental issues affecting rural America by using a wide range of strategies. One rather suc-cessful strategy that a number of grassroots organi-zations have used is to embarrass the land grant system into examining more sustainable farming practices. A second strategy is that of trying to develop a new leadership that is concerned about groundwater quality and related environmental, social, and economic issues. A third strategy is to develop a system of support for those individuals within the system that recognize the need for reforming farming practices but are in a minority and meet substantial institutional resistance. A and meet substantial institutional resistance. A fourth strategy is to know about and understand the decision-making processes used by the land grant system or other relevant public institution. The fifth strategy is to play the role of 'watchdog' by monitoring how the implementation process is being carried out. (See also W91-11162) (Korn-W91-11204

## IN THE LAND OF THE GIANTS: GRASS-ROOTS ORGANIZING IN CALIFORNIA'S CENTRAL VALLEY.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 411-416.

Descriptors: \*Agricultural chemicals, \*Nonpoint pollution sources, \*Organizations, \*Public participollution sources, "Organizations, "Fuolic partici-pation, "Water pollution prevention, Administra-tive agencies, Agriculture, Environmental protec-tion, Farm management, Legislation, Policy making, Water pollution.

The California Action Network (CAN) is a grass-The California Action Network (CAN) is a grass-roots, membership organization whose overall mis-sion is to increase the economic and political strength and well being of all farmers, farm work-ers, and rural inhabitants, and to maintain rural resources and rural values. Strategies used by CAN include grassroots lobbying, community or ganizing, advocacy, and public education to ad-dress a variety of issues affecting rural California. The CAN approach to groundwater protection from agricultural chemicals has both short-term and long-term goals. In the short term, the CAN has sponsored or supported several key pieces of legislation to strengthen existing pesticide laws. For the long-term, the CAN promotes sustainable agriculture, as a means of eliminating the hazards of pesticides altogether. The Pesticide Contaminaof pesticiaes attogether. In Pesticiae Contamina-tion Prevention Act and Proposition 65 are exam-ples of short term, quick fixes to make incremental improvements in a system of agricultural produc-tion that is inherently unsafe. On the other hand, tion that is limiterately disease. On the other hand, the Sustainable Agriculture Research and Education Act addresses the long term needs of rural California by funding research on agricultural practices that reduce or eliminate the use of toxic practices that reduce or eliminate the use of toxic pesticides. Both approaches are needed, but it is the long term approach of sustainable agriculture that enables substantive change to happen in agriculture and groundwater protection. (See also W91-11162) (Korn-PTT) W91-11205

#### PAST, PRESENT, AND FUTURE OF WATER USE AND MANAGEMENT.

Academy of Natural Sciences of Philadelphia, PA. For primary bibliographic entry see Field 4A. W91-11209

W91-11272

Water Quality Control-Group 5G

NATURE OF SUSPENDED SOLIDS AND IRS1A-LISSI DATA: A CASE STUDY OF TAWA RESERVOIR (NARMADA BASIN), Jawaharlal Nehru Univ, New Delhi (India). School of Environmental Sciences. V. K. Choubey, and V. Subramanian. Remote Sensing of the Environment RSEEA7, Vol. 34, No. 3, p 207-215, December 1990. 4 fig, 3 tab. 16 ref.

Descriptors: \*Remote sensing, \*Suspended solids, \*Tawa Reservoir, \*Water quality, Data acquisition, Data interpretation, Evaluation, India, Indian Remote Sensing Satellite-1A, Linear Imaging Self-Scanning, Mineralogy, Narmada River Basin, Particle size, Satellite technology.

Spectral digital data from the Indian Remote Sensing Satellite-IA Linear Imaging Self-Scanning (IRSIA-LISSI) sensor were analyzed to determine the feasibility of quantifying the concentration of suspended solids in the water by this sensor. For this purpose, a small tributary (Tawa) of a major river basin (Narmada Basin) in central India was river basin (Narmada Basin) in central india was studied for ground truth evaluation of the IRSIA-LISSI digital data. Tawa Reservoir water samples were collected on 20 October 1988, concurrent with IRSIA overpass. The samples were analyzed to determine the concentration of total suspended to determine the concentration of total suspended matter, grain size, and mineralogy. The results indicate that, in the concentration range between 10 mg/L and 50 mg/L, a positive functional relationship exists between the concentration of suspended solids and the visible wavelength bands 1, 2, and 3 (0.45-0.68 micrometers). Mineralogy and grain size are the main factors that influence the reflected radiance at a lower concentration level. grain size are the main factors that influence the reflected radiance at a lower concentration level (10-50 mg/L) of suspended solids. It can be concluded that as the concentration of suspended solids in the 10-50 mg/L range increases, the spectral response increases. IRISIA-LISSI data provide a good foundation for further development of remote sensing as a practical tool in the estimation of suspended solids. (Author's abstract) W91-11221

BUBBLELESS AERATION.
Minnesota Univ., Minneapolis. Dept. of Civil and
Mineral Engineering.

M. J. Semmens.
Water Engineering and Management WENMD2,
Vol. 138, No. 4, p 18-19, April 1991. 1 fig.

Descriptors: \*Aeration, \*Lake restoration, \*Membrane processes, \*Oxygenation, \*Water quality control, \*Water treatment, Diffusion, Field tests, Gases, Lake St Paul, Mathematical equations, Minnesota, Performance evaluation.

A hollow-fiber membrane aerator for the oxygenation of water has been developed and tested. The aerator houses a bundle of sealed, hollow, gaspermeable fibers that are filled with pure oxygen under pressure. The water to be aerated is pumped over the outside of the fibers. The device can aerate water without forming bubbles. The oxygen diffuses across the porous fiber walls and dissolves directly into the water that flows over the outer surface of the membrane. The highly oxygen-persurface of the membrane. The highly oxygen-per-meable membrane transfers oxygen to the water so meable membrane transfers oxygen to the water so quickly that transfer takes place as if the membrane were not present. In essence, the fibers act as elongated, stationary bubbles of oxygen. The hollow fibers are made from microporous polypropylene membrane, and measure approximately 200-400 micrometers in diameter. The small size of the fibers means that a very large surface area of membrane can be installed in a small aerator. The basic equation for oxygen transfer is dC/dt = K sub La (C\*-C), where K sub La is the overall oxygen transfer coefficient, C\* is saturation concentration in the dissolved oxygen concentration in equilibrium with the air or oxygen), and C is the equilibrium with the air or oxygen), and C is the actual concentration of dissolve oxygen in the actual concentration of dissolve oxygen in the water. Oxygen transfer is accomplished by making K sub La and C\* large. Field tests were conducted with a 1000-fiber module in Lake St. Paul, Minnesota, over a period of 5 mo. The data show a trend of decreased transfer over the test period, but this is attributable to temperature changes. The memorated brane consistently performed better than expected in the field, with no evidence of membrane fouling. (Rochester-PTT)

W91-11222

ANALYTICAL MODELING OF AQUIFER DE-CONTAMINATION BY PUMPING WHEN TRANSPORT IS AFFECTED BY RATE-LIMIT-ED SORPTION.

ED SORPTION.
Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Civil Engineering.
M. N. Goltz, and M. E. Oxley.
Water Resources Research WRERAQ, Vol. 27, No. 4, p 547-556, April 1991. 6 fig, 34 ref.

Descriptors: \*Aquifer restoration, \*Cleanup operations, \*Mathematical models, \*Pump wells, \*Water pollution treatment, Aquifers, Comparison studies, Data interpretation, Groundwater pollution, Laplace equation, Model studies, Numerical analysis, Solute transport, Sorption.

Aquifer cleanup efforts at contaminated sites frequently involve the operation of a system of extraction wells. Contaminant load discharged by extraction wells typically declines with time, asymptotically approaching a residual level. Such behavior could be due to rate-limited desorption of an organic contaminant from aquifer solids. An analytical model was developed that accounts for rate-limited desorption of an organic solute during cleanup of a contaminated site. Model equations are presented that describe transport of a sorbing contaminant in a converging radial flow field, with desorption described by (1) equilibrium, (2) first order rate, and (3) Fickian diffusion expressions. The model equations are solved in the Laplace domain and numerically inverted to simulate contaminant concentrations at an extraction well. A Laplace domain solution for the total contaminant mass remaining in the aquifer also is derived. Ratemass remaining in the aquifer also is derived. Rate-limited sorption can have a significant impact on aquifer remediation. Approximate equivalence among the various rate-limited models also is demonstrated. (Author's abstract) W91-11235

OPTIMAL DATA ACQUISITION STRATEGY FOR THE DEVELOPMENT OF A TRANSPORT MODEL FOR GROUNDWATER REMEDI-

ATION.
Facolta di Ingegneria, Reggio Calabria, Italy.
T. Tucciarelli, and G. Pinder.
Water Resources Research WRERAQ, Vol. 27,
No. 4, p 577-588, April 1991. 6 fig. 5 tab, 42 ref.

Descriptors: \*Algorithms, \*Cleanup operations, \*Data acquisition, \*Groundwater pollution, \*Rehabilitation, \*Water pollution treatment, Cost analysis, Finite element method, Groundwater management, Mathematical equations, Mathematical models, Optimization, Simulation analysis.

The reliability of groundwater management algorithms is limited in large part by the uncertainty present in the model parameters. Because the field parameter measurement costs and remediation costs must be supplied by the same financial source; the classical optimization procedure does not minimize the real total remediation investment. An algorithm was developed that is capable of finding the total minimum for the sum of both the finding the total minimum for the sum of both the measurement and the pumping costs. A chance-constrained technique is used to cast the optimization problem in stochastic form, relating the concentration covariance matrix to the log-transmissivity covariance matrix by means of the transport equations and a first-order approximation for uncertainty. The simulation model solves the steady state flow equations on finite element triangular mesh and the transport equations using the backward method of characteristics. The resulting nonlinearly constrained optimization problem is solved using the quasi-linearity algorithm; this algorithm is designed to find a good initial point for the local minimum search when the feasible domain is not convex. (Author's abstract)

SITUATION OF WATER SUPPLY IN THE NEW LANDER OF THE FEDERAL REPUBLIC OF GERMANY. For primary bibliographic entry see Field 5F.

HYDRAULICKING IN ENVIRONMENTAL PROTECTION AND RESTORATION.

Y. N. D'yakov Hydrotechnical Construction HYCOAR, Vol. 24. No. 6, p 349-353, December 1991. 2 fig, 3 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, pp. 1-4, June, 1990.

Descriptors: \*Dredging, \*Hydraulic fill, \*Land reclamation, \*Soviet Union, \*Water pollution prevention, Civil engineering, Design criteria, Hydraulic machinery, Reservoirs, Revegetation, Tailings dumps.

Hydraulic filling of certain land areas in the Soviet Union can have a beneficial environmental effect.

One application is in the polder reclamation of shoals of large water power reservoirs where the shoals constitute a 'no-man's land' of little economic value. Use of hydraulic mining methods in ex-traction of minerals is inexpensive, but it leads to traction of funerais is inexpensive, our it reads to the creation of tailings dumps. Care must be taken in building tailings dumps not to release waste into the local water and air. The new environmental protection technology of forming hydraulic dumps includes: an evaluation of the state of sloping structures and internal zones of hydraulic-fill masses tures and internal zones of hydraulic-full masses with the use of routine geomechanical monitoring and special engineering-geological regionalization; geomechanical substantiation of the designs of the slopes of embankments and measures on forcing consolidation of water-saturated soil; creation of components of a designee autem, within stores. components of a drainage system within various zones of hydraulic dumps to increase their capaczones of nydraulic dumps to increase their capacity, accelerating the turnover of water and providing the possibility of subsequent use of the hydraulic-fill territories; and dust suppression by hydraulic placement of a loam blanket on the dust-producing surface. At two dumps of the Lebedinsk Mining and Concentration Integrated Plant and KMA-Ore Integrated Plant, a total of 938 ha of previsions of the processing the proces fertile chernozem land, including 328 ha of previ-ously unsuitable lands (ravine slopes), were revege-tated and returned to agriculture. (Rochester-PTT)

CHARACTERISTICS OF MINING QUARRIES ON HYDRAULIC-FILL DUMPS. For primary bibliographic entry see Field 8A.

SELECTION OF THE OPERATING REGIME OF THE ONEGA-SVIR' WATER SYSTEM UNDER CONDITIONS OF INCREASING WATER CONSUMPTION.

For primary bibliographic entry see Field 6D. W91-11288

SOIL CLEAN UP BY IN-SITU AERATION: VI. EFFECTS OF VARIABLE PERMEABILITIES. Malaga Univ. (Spain). Dept. de Ingenieria Qui-

C. Gomez-Lahoz, J. M. Rodriguez-Maroto, and D.

Separation Science and Technology SSTEDS, Vol. 26, No. 2, p 133-163, 1991. 23 fig, 5 tab, 15 ref.

Descriptors: \*Cleanup, \*In situ treatment, \*Mathematical models, \*Model studies, \*Soil aeration, \*Soil management, \*Volatile organic compounds, \*Water pollution prevention, Permeability, Sensitivity analysis, Site remediation, Soil contamination, Soil water, Vadose zone, Water table.

Soil vapor stripping (vacuum extraction) has become an important tool in the remediation of hazardous waste sites contaminated with volatile organic compounds (VOCs) in the vadose zone. A mathematical model for in-situ soil vapor stripping was developed and used to examine the effects of a was developed and used to examine the effects of a spatially variable pneumatic permeability tensor on the rate of cleanup of a site contaminated with VOCs. A study was made of the effects of lens-shaped domains of low permeability on the shapes of the streamlines of soil gas in the vicinity of a vapor stripping horizontal lateral slotted pipe and

## Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

## **Group 5G—Water Quality Control**

on the rate of cleanup of the soil in the domain of influence of this pipe. The effects of spatial variation in the soil moisture were also examined. Runs were made with low-permeability clay lenses placed at various locations in the domain of interest. The model permits one to carry out a sensitivity analysis of the effects of heterogeneity in the permeability, and to develop strategies for minimizing the damaging effects of domains of low permeability. Vapor stripping of rather wet soil is likely to be a very slow process. In such situations, efforts to reduce surface recharge, to draw down the level of the water table by pumping, and to allow adequate time for soil drainage after the water table had been drawn down may be necessary in order to achieve acceptable containment removal rates by soil vapor stripping. (See also removal rates by soil vapor stripping. (See W90-11832 and W91-01756) (VerNooy-PTT)

USE OF LIGAND-MODIFIED MICELLAR-EN-HANCED ULTRAFILTRATION IN THE SE-LECTIVE REMOVAL OF METAL IONS FROM

Oklahoma Univ., Norman. Inst. for Applied Sur-

factant Research.
For primary bibliographic entry see Field 5D.
W91-11318

DENITRIFICATION IN LABORATORY SAND COLUMNS: CARBON REGIME, GAS ACCUMULATION AND HYDRAULIC PROPERTIES. Ben-Gurion Univ. of the Negev, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research. M. I. M. Soares, C. Braester, S. Belkin, and A.

Abeliovich. Water Research WATRAG, Vol. 25, No. 3, p 325-332, March 1991. 6 fig, 3 tab, 16 ref.

Descriptors: \*Aquifers, \*Biological treatment, \*Denitrification, \*In situ treatment, \*Restoration, \*Water pollution, Anaerobic bacteria, Biomass, Clogging, Hydraulic conductivity, Nitrates, Per-meability, Porosity, Sand filters.

The biological approach to restoration of nitrate polluted aquifers relies on the capacity of faculta-tive anaerobic bacteria, in the absence of oxygen, to utilize nitrate as a terminal electron accepto their respiratory process via a pathway known as denitrification. In situ denitrification treatment is denitrification. In situ denitrification treatment is achieved by injecting an organic carbon source into the aquifer. Although build-up of biomass and a marked decrease in permeability are observed, removal of accumulated gas brings significant increases in permeability. Microbiological denitrification in a sandy matrix was studied by means of laboratory sand columns operated at continuous and pulse feed regimes. Gas production resulting from the biological activity played a major role in modifying the hydraulic properties of the column, leading to decreases in hydraulic conductivity and porosity, higher water velocities through the porosity, higher water velocities through the column, higher dispersion and anomalities in the head difference to flow rates ratios. All of these head difference to flow rates ratios. All of these effects were more pronounced when formate, the carbon source used, was supplied continuously: microbial activity and gas production were concentrated at the top of the column, leading to almost complete clogging. When the formate was supplied in pulses, activity and gas production dispersed, leading to relative uniformity in the physical parameters measured and a homogeneous physical parameters measured and a homogeneous physical parameters measured and a homogeneous appearance of the column. The results suggest that in a future in situ aquifer denitrification plant, pulse application of the carbon source is preferable to a continuous supply regime. (Doyle-PTT) W91-11330

APPLICATION OF SUPPORTED LIQUID MEMBRANES FOR REMOVAL OF URANIUM FROM GROUNDWATER. Argonne National Lab., IL. Chemistry Div. R. Chiarizia, E. P. Horwitz, P. G. Rickert, and K.

M. Hodgson. Separation Science and Technology SSTEDS, Vol. 25, No. 13/15, p 1571-1586, 1990. 8 fig, 4 tab,

Descriptors: \*Cleanup operations, \*Groundwater pollution, \*Membrane processes, \*Separation tech-

niques, \*Uranium, \*Water pollution treatment, Chemical recovery, Hanford, Polymers.

The separation of uranium from Hanford site groundwater was studied by hollow-fiber supported liquid membranes (SLM). The carrier bis(2,4,4trimethylpentyl)phosphinic acid, H(DTMPeP), contained in the commercial extractant Cyanex 272, was used as the membrane carrier because of its selectivity for U over calcium and magnesium. The water soluble complexing agent, 1-hydrox-yethane-1,1-diphosphonic acid (HEDPA) was used as the stripping agent. Polypropylene hollow-fibers and n-dodecane were used as polymeric support and diluent, respectively, Laboratory scale hollowand diluent, respectively. Laboratory scale noilow-fiber modules were employed in a recycling mode, using as feed synthetic groundwater at pH 2, to confirm the capability of the proposed SLM system to separate and concentrate U(VI) in the strip solution. Information was obtained on the strip solution. Information was obtained on the U(VI) concentration factor and on the long-term performance of the SLMs. Encouraging results were obtained both with a conventional module and with a module containing a carrier solution reservoir. Industrial scale modules were used at Hanford to test the SLM separation of U(VI) from real contaminated groundwater. The uranium con-centration was reduced from approximately 3,500 ppb to about 1 ppb in a few hours. (Author's abstract) W91-11370

TOWARDS MANAGEMENT OF ENVIRON-MENTAL PROBLEMS IN EGYPT. Massachusetts Univ., Amherst. Dept. of Political For primary bibliographic entry see Field 6G. W91-11373

MIGRATION AND TREATMENT OF A DENSE AQUEOUS CONTAMINANT SOURCE AND

Rutgers - The State Univ., Piscataway, NJ. Dept. of Chemical and Biochemical Engineer Nulgers - The State Univ., riscataway, NJ. Dept. of Chemical and Biochemical Engineering. J. V. Lepore, D. S. Kosson, and R. C. Ahlert. Journal of Environmental Science and Health (A) JESEDU, Vol. 26, No. 1, p 97-119, 1991. 8 fig, 5

Descriptors: \*Groundwater pollution, \*In situ treatment, \*Path of pollutants, \*Water pollution treatment, Analytical methods, Biodegradation, Cleanup operations, Gas chromatography, Industrial wastes, Mass spectroscopy, Model studies, Organic compounds, Precipitation, Sulfates.

For more than two decades, a chemical processing waste liquor containing substantial concentrations of organic species and ammonium sulfate (up to 38,000 mg/L sulfate), was discharged into shallow trenches adjacent to a manufacturing plant. The waste materials have reacted and migrated to the subsurface domain; a multi-phase plume has resulted. Source material was assayed for surface tension, viscosity, and density, followed by mass spectroscopic analysis. GC/MS results indicated that a substantial part of the waste was comprised of short chain volatile fatty acids. The surface tension of contaminated groundwater correlated well with organic carbon content. Source material clearly had considerable surfactant properties associated with it, with a surface tension 60% lower than pure water. Local soils were also characterized ( 90% sand, 4% silt, and 6% clay) since migration of sain, 40 ain, and o've clays since ingration or the plume depends of both the physical properties of the waste and of the solid support matrices. A laminar jet model was developed to explain transport behavior. Process design considerations tend to favor an in situ treatment process. It appears that sulfate removal by precipitation as a prelimi-nary step can be followed by groundwater recov-ery and above ground microbial treatment. (Doyleery an W91-11380

DANUBE RIVER BASIN: NEGOTIATING SET-TLEMENTS TO TRANSBOUNDARY ENVI-RONMENTAL ISSUES. International Inst. for Applied Systems Analysis, Laxenburg (Austria). J. Linnerooth. Natural Resources Journal NRJOAB, Vol. 30, No. 3, p 629-660, 1990. 2 tab.

Descriptors: \*Danube River, \*Governmental interrelations, \*International commissions, \*International law, \*Legal aspects, \*Water quality manageal law, \*Legal aspects, \*Water quanty management, \*Water resources management, Competing use, Danube Declaration, Decision making, Environmental policy, International agreements, Planning, Treaties, Water law, Water policy.

The Danube is one of the most international river basins in the world. Recently, representatives of eight European countries bordering the Danube declared their willingness to cooperate on its man-agement, especially in confronting the mounting problems of water pollution. In the absence of a comprehensive, basin-wide planning authority, this Danube Declaration is an important first step in establishing cooperative policies. Any management strategy will involve tradeoffs. Electrical power generation, navigation, and waste disposal, for example, conflict with such uses as irrigation, fisheries, tourism, and supplies of potable water. Irrigation requires enormous quantities of water and may seriously reduce the supply of water for other purposes. The signing ministers of the Danube Declaration have emphasized that a balanced management of the Danube river can be achieved only through cooperation among the eight riparian countries. Establishing that cooperation, especially on improving water quality of the Danube, will be complicated by the power asymmetry between upstream and downstream countries, the scientifically complex and ill-defined nature of the prob-lem, and the lack of a multilateral decision-making river basin authority. In the absence of such a authority, progress can be made only through bilateral agreements covering small bounded seg-ments of the problem. How problems and disputes over the shared uses of water resources have been negotiated and resolved, how past and present institutions have succeeded or failed, and the ways in which the analyst can contribute to the substa tive and procedural issues, are questions of increasing concern if the world is to cope with the expanding menu of transboundary and cross-media environmental problems. (Doyle-PTT) W91-11387

REGIONAL APPROACH TO SALINITY MAN-AGEMENT IN RIVER BASINS. A CASE STUDY IN SOUTHERN IRAN.

Agricultural Univ., Wageningen (Netherlands). Dept. of Hydraulics and Catchment Hydrology. K. Shiati.

Agricultural Water Management AWMADF, Vol. 19, No. 1, p 27-41, January 1991. 2 tab, 8 fig, 20 ref.

Descriptors: \*Desalination, \*Iran, \*River basins, \*Saline water, \*Storage reservoirs, \*Water quality control, Irrigation effects, Model studies, Seasonal variation, Stratification

In the Shapur and Dalake basin, engineering measures seem promising for salinity control. Among the measures for salt disposal, collection and evaporation of polluted sources in ponds is the most practicable and feasible measure. However, greater benefits can be gained by implementation of salt benefits can be gained by implementation of salt mitigation measures. The model DYRESM was used to simulate the salinity distribution in the planned Jarreh reservoir. Results of the simulation indicate that the Jarreh storage reservoir can regulate and reduce the salt concentration of the irrigalate and reduce the sait concentration or the irriga-tion water to a range between 1500 and 2400 mg/L. Compared with between 1000 and 4200 mg/L for the original river salinity. Furthermore, the diversion of the most saline inflow in summer also decreases salinity. Careful management of the storage reservoir, making use of the natural stratification processes in its water, may further improve the quality of the water releases. (Author's abstract) W91-11432

## Water Quality Control-Group 5G

PRODUCTION FUNCTIONS RELATING CROP YIELD, WATER QUALITY AND QUANTITY, SOIL SALINTIY AND DRAINAGE VOLUME. California Univ., Riverside. Dept. of Soil and Environmental Sciences.

For primary bibliographic entry see Field 3C. W91-11434

GROUND WATER CONTAMINATION FROM AGRICULTURAL SOURCES: IMPLICATIONS FOR VOLUNTARY POLICY ADHERENCE FROM IOWA AND VIRGINIA FARMER'S AT-

THYUDES.

New Hampshire Univ., Durham. Dept. of Resource Economics and Community Development.

J. M. Halstead, S. Padgitt, and S. S. Batie.

American Journal of Alternative Agriculture, Vol.

5, No. 3, p 126-133, 1990. 4 tab, 29 ref.

Descriptors: \*Agricultural chemicals, \*Agricultural practices, \*Groundwater pollution, \*Groundwater quality, \*Public opinion, \*Water pollution control, Agricultural runoff, Farm management, Nitrates, Pesticides.

The potential for voluntary adoption of agricultural management practices that reduce risk of groundwater contamination and how farm operators' attitudes regarding the environment might affect the success of voluntary programs are examined. Results from two surveys indicate that farmers' behavior and attitudes in Virginia and Iowa ers' behavior and attitudes in Virginia and Iowa reveal that both groups consider the groundwater issue to be a serious problem to which they are contributing. This awareness is a significant first step in prompting consideration of management practices that reduce the threat to groundwater quality. The surveys also revealed that the worst offenders, i.e., farmers applying nitrogen well above agronomic recommendations, were those with the least concern about the problem. If major which in farming rectifies are a cooper soluntarily. with the least concern about the problem. If major shifts in farming practices are to occur voluntarily, major incentives or disincentives are needed. Even though the concern about groundwater quality is high, the documented risks perceived by farmers are not strongly convincing. The economic incentives for change are questionable at best. Voluntary adoption of best management practices is only one of several policy options. Ultimately, policies designed to reduce groundwater contamination designed to reduce groundwater contamination may need a mix of strategies, including economic incentives and disincentives, zoning and land use restrictions, environmental regulations and bans on agricultural chemicals. (Author's abstract) W91-11437

HONG KONG: CAN THE DRAGON CLEAN ITS

Hong Kong Univ. Centre of Urban Studies and Urban Planning. Urban Planning.
P. Hills, and W. Barron.

Environment ENVTAR, Vol. 32, No. 8, p 16-45, October 1990. 28 ref.

Descriptors: \*Air pollution, \*Environmental policy, \*Environmental protection, \*Environmental quality, \*Farm wastes, \*Hong Kong, \*Sewage, \*Water pollution control, Heavy metals, Industrial wastes, Nitrogen oxides, Noise, Particulate matter, Sulfor divide.

Rapid urbanization and industrialization with few environmental controls have made Hong Kong one of the noisiest and most crowded places in the one of the noises and most crowded piaces in the world. Many of Hong Kong's current pollution problems are reminiscent of scenes common in Europe and North America decades ago. The government's first attempt at establishing an environmental department dates back to 1978, when the Environmental Protection Unit (FPI) was created mental department dates back to 1978, when the Environmental Protection Unit (EPU) was created and staffed by just five professional officers. EPU is currently staffed by 700 people and its role includes enforcement and environmental monitor-ing. Other institutional structures have been cre-ated; however, it is still difficult for the public to participate effectively in the formulation and evalparticipate effectively in the formulation and eval-uation of environmental policy measures. Hong Kong has failed to provide significant support for environmental interest groups. Generally, the terri-tory's approach to environmental management is of the command and control type. Hong Kong's

record for effective environmental protection has record for effective environmental protection has been mixed. Curbing industrial source pollution has only begun to be addressed. Although Hong Kong is taking some sweeping actions and is making incremental improvements in a number of areas to reduce pollution levels, overall environmental quality is continuing to decline and many important sources of pollution continue largely unabated because of both the grandfathering system of exemptions, the time requirements for infrastructure development, power of special interest groups and staffing problems. (Author's abstract)

REMEDIATION OF FLOATING, OPEN WATER OIL SPILLS: COMPARATIVE EFFICACY OF COMMERCIALLY AVAILABLE POLYPROPYLENE SORBENT BOOMS. Millsaps Coil., Jackson, MS. Dept. of Geology. E. L. Schrader.

Environmental Geology and Water Sciences EGWSEI, Vol. 17, No. 2, p 157-166, March/April 1991. 5 fig, 7 tab, 5 ref.

Descriptors: \*Cleanup operations, \*Containment booms, \*Oil pollution, \*Oil skimmers, \*Oil spills, \*Remediation, \*Water pollution control, Comparison studies, Sorption.

Sorbing the liquid hydrocarbons with polypropylsortong the national nytrice and less complex means of treating such events. There are, however, a variety of commercially available booms which display different performances in sorbing different viscosity hydrocarbons. A protocol to evaluate viscosity hydrocarbons. A protocol to evaluate polypropylene booms for performance efficiency in various weather and hydrocarbon viscosity scenarios was developed. The most commonly used sorbent products were evaluated with the new test procedures. The testing format included the following: rate of absorption test, capacity test, height of boom, and boom weights, packing and shedding. According to the data from this project, the top three overall performing booms are ERGON, 3M, and Matarah. The two best performing booms in total gallons of oil per boom section are 3M and ERGON. Other criteria than those tested in this project may be extremely important to ascertain project may be extremely important to ascertain boom preference in a given spill or application, and this work in no way specifies the best boom to use in a specific application. (Author's abstract) W91-11447

FOREST INDUSTRY WASTEWATERS. For primary bibliographic entry see Field 5D. W91-11467

TRENDS IN WATER POLLUTION CONTROL IN THE FINNISH PULP AND PAPER INDUS-TRY

National Board of Waters, Helsinki (Finland).

J. Junna, and S. Ruonala. Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 1-10, 1991. 4 fig, 4 tab, 15 ref.

Descriptors: \*Bleaching wastes, \*Finland, \*Pulp and paper industry, \*Pulp wastes, \*Water pollution control, Activated sludge treatment, Biological oxygen demand, Chemical oxygen demand, Chlorinated hydrocarbons, Industrial wastewater, Suspended Likely Wester, Suspended L pended solids. Wastewater treatment

There are about 50 paper and pulp mills in Finland. Pulp and paper production has increased quite rapidly during recent decades. The greatest increase has occurred in the production of bleached kraft pulp and mechanical pulp. Discharge permissions in Finland have recently included total phosphorus and chemical oxygen demand, in addition sions in Finland have recently included total phosphorus and chemical oxygen demand, in addition to the conventional water pollution control parameters of suspended solids and biological oxygen demand. In the near future, requirements for chlorianted organic compounds are also expected. For reducing chlorinated organic compounds, the development of new cooking and bleaching processes will probably be examined. Oxygen delignification will become more common. Other external methods can be developed and improved for the reduction of chlorinated organics. Nutrient loadings can

be reduced by external purification methods. Activated sludge treatment will be the basic method of external purification. The future will bring increased research and development in the area of tertiary treatment. (See also W91-11467) (Mertz-W91-11468

TRENDS IN POLLUTION CONTROL IN THE SWEDISH PULP AND PAPER INDUSTRY. National Swedish Environment Protection Board, Solna. Forest Industry Section.
S. Lagergren, and E. Nystrom.
Water Science and Technology WSTED4, Vol.
24, No. 3/4, p 11-17, 1991. 7 tab.

Descriptors: \*Chlorinated hydrocarbons, \*Pulp and paper industry, \*Pulp wastes, \*Sweden, \*Water pollution control, Bleaching wastes, Chemical wastes, Industrial wastes, Kraft mills, Organic pollutants, White water.

Current production figures, control measures and discharges from the Swedish pulp and paper industry were examined in conjunction with future trends and possibilities. Emphasis was placed on discharges of chlorinated organic substances and internal methods to control such methods. The internal methods to control such methods. In the bulk of discharges come from the manufacture of chemical pulp and within this sector, from kraft (sulfite) pulp. The Swedish National Environmental Protection Agency mandates that each plant should reduce its discharges from the manufacture of unbleached pulp by means that include the following internal process measures: introduction of decreate the more all colories of the section of the of dry bark removal; closure of water systems; effective washing equipment; well developed systems to deal with temporary discharges (spills); and treatment of condensate by steam-stripping and treatment of condensate by steam-stripping and retrieval for further use. The long-term objective is the virtually complete elimination of the discharge of chlorinated organic compounds by the pulp industry. To achieve this requires development of process technology and an almost totally closed water process involving the retrieval and incineration of dissolved substances. Measures adopted to limit discharges into water from the manufacture of mechanical pulps comprise an opti-mal combination of internal process and external features. Internal measures consist of system closures, where water from screening, bleaching and dewatering is circulated to the grinder or refiner. dewatering is circulated to the grinder or refiner.

Another step is to separate contaminated from uncontaminated water. Paper mills are often large, modern units integrated with pulp production. In order to achieve a continuously high degree of closure in integrated paper mills, the supply of white water must be ensured even when variations occur in the flow balances. This minimizes the size of inchestest discharges. The large suppliers are of inadvertent discharges. The large numbers and quantities of chemical additives and coloring agents should be easily degradable and nontoxic. (See also W91-11467) (Mertz-PTT) W91-11469

REGULATORY REQUIREMENTS FOR PULP AND PAPER MILL EFFLUENT CONTROL: SCIENTIFIC BASIS AND CONSEQUENCES. COWIconsult, Lyngby (Denmark).

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 19-31, 1991. 1 fig, 8 tab, 36 ref.

Descriptors: \*Europe, \*Industrial wastes, \*Pulp and paper industry, \*Pulp wastes, \*Water policicy, \*Water policion control, Chemical oxygen demand, Chlorinated hydrocarbons, Hazardous wastes, Hydrogen ion concentration, Stream pollution, Streamed et oblist.

The Ministers' Declaration from the Second North The Ministers' Declaration from the second Nortin Sea Conference recommended the goal of dimin-ishing the discharge of hazardous substances via rivers by 50% over the next 10 years. Discharge reductions of persistent halogenated compounds from pulp and paper mill effluents were adopted by the Paris Convention later. Based on a study conducted for the European Economic Community Commission, the following must be fulfilled to reach this goal: For historic reasons the regulation

### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

## Group 5G-Water Quality Control

of the pulp and paper industry includes some parameters which may not be the most appropriate ones, for example five-day biological oxygen demand and adsorbable organohalogens. Regulating the bleached pulp mills by absorbable organohalogens/total chlorinated organics is not recommended. Polychlorodibenzo-p-dioxins and polychlorodibenzo furans are very difficult to regulate at present. Regulation of polychlorinated phenolics in the effluent may prove to be a valid indirect measure of tetrachlorodibenzo dioxin equivalents, but this has yet to be novoen. To ensure sufficient this has yet to be proven. To ensure sufficient removal of hazardous compounds, it is recommended that standards for total suspended solids be stringent, as the major fraction of hazardous compounds is associated with suspended solids. Effuent control should be based on pH, chemical oxygen demands using dichromic acid, and total suspended solids and polychlorinated phenolics. At present there are not sufficient data available to establish a regulation based on these parameters. (See also W91-11467) (Author's abstract) W91-11470

GOALS, REGULATIONS AND INFORMATION NEEDS FOR WASTEWATER DISCHARGE MANAGEMENT-AN AMERICAN PERSPEC-TIVE.

National Council of the Paper Industry for Air and

Stream improvement, Inc., New York.
I. Gellman, and W. J. Gillespie.
Water Science and Technology WSTED4, Vol.
24, No. 3/4, p 33-36, 1991.

Descriptors: \*Pulp and paper industry, \*Pulp wastes, \*Regulations, \*Water pollution control, Dioxins, Environmental protection, Industrial wastes, Kraft mills, Water law, Water

The American paper industry currently operates 600 paper mills and 360 pulp mills, of which 124 are in the kraft category. The industry is broadly distributed across the U.S., with half the kraft mills in the South and significant numbers in the Northeast, Midwest and the Pacific Coast regions. National and regional regulations flow from the regularly amended Clean Water Act which provides for a dual approach; technology. The part of the proposed and water the contract of t arry amended clean water Act which provides for a dual approach: technology-based and water quality-based standards. These are implemented in most cases by state agencies operating within a strong oversight structure established by the EPA. strong oversign structure estations and with extensive public participation through the mass communication media and the formal judicial process. Intertwined with a number of information needs is the recognition that some chlororganics have reached trace compound differentiation and detectability limits where disagreements exist over whether there is significant bioresponse. This is the case for 2,3,7,8-dioxin where changes in detectabilcase for 2,3,7,8-droxin where changes in detectability over the past decade from the parts per billion to parts per quadrillion level have been achieved. National assessments of acceptable daily intake levels range from 0.006 to 10 picagram per kg body weight per day, or a range in acceptability from one country to another of over 1000, with the most restrictive limitations in force in the United States. Passes hand debts exercible in second-order States. Research and data assembly is proceeding in all the listed areas on an international scale, as is the development of new regulations. (See also W91-11467) (Mertz-PTT)

DEVELOPMENT OF ENVIRONMENTAL CONTROL LEGISLATION AND EFFLUENT STANDARDS FOR AUSTRALASIAN WOOD PROCESSING INDUSTRIES.

Forest Research Inst., Rotorua (New Zealand).

Wood Technology Div. J. S. Gifford, and P. N. McFarlane. Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 37-44, 1991. 3 tab, 17 ref.

Descriptors: \*Australia, \*Industrial wastes, \*Legislation, \*New Zealand, \*Water pollution control, \*Water pollution prevention, \*Water quality standards, Environmental protection, Hazardous wastes, Legal aspects, Licensing, Pulp and paper industry, Water policy. The Australasian wood processing industry is poised for a substantial expansion over the next 20 years. Australia, which is presently an importer, is developing plans to become a net exporter of forest products, whereas New Zealand's wood supply is expected to double over this period. In both counexpected to double over this period. In both countries, the expansion of procession capacity will be required to occur in a sustainable and environmentally sound manner. For example, the Australian Federal Government has developed environmental guidelines for new bleached Eucalyptus kraft pulp mills, with the New Zealand government presently enacting a comprehensive Resource Management Act. The Hazards Control Commission, established in conjunction with the Resource Management Act, will be an independent central government body. It will be responsible for controlling the importation, production, use and disposal of hazardous substances and new organisms. For each hazardous substances and new organisms. For each hazardous substances and conscient and operation, production, use and disposal of hazardous substances and new organisms. For each hazardous substances and new organisms. persistence and toxicity to the ecosystem will be assessed as part of the licensing process. This is the first time these considerations will be made in New nd, as previous legislation has focused on the threat to human health and the explosive/flamma-ble nature of the compounds. In addition, the Haz-ards Control Council will be establishing a cradle to grave tracking system for very hazardous sub-stances. (See also W91-11467) (Mertz-PTT) W91-11472

PROCESS INTERNAL MEASURES REDUCE PULP MILL POLLUTION LOAD. Helsinki Univ. of Technology, Espoo (Finland). J. Gullichsen.

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 45-53, 1991. 3 fig, 3 tab.

Descriptors: \*Bleaching wastes, \*Hanford Site process control, \*Pulp and paper industry, \*Pulp wastes, \*Wastewater treatment, \*Water pollution control, Chlorinated hydrocarbons, Chlorine, Environmental protection, Industrial wastes, Lignin, Operating costs

There are several options to modify present pulping processes towards reduced environmental impact. The industry is readily adopting those that have reached the status of proven technology. New process variations are being developed. Process internal measures alone will not be sufficient to reach acceptable levels. External effluent treatment reach acceptable levels. External effluent treatment will always be required. Internal abatement measures should concentrate on reducing pollution potential at the very source but also on improving the conditions for efficient external treatment. Standard unbleached softwood kraft pulp contains roughly 5% lignin after cooking and washing. Hardwood pulp holds considerably less. Increased loss of carbohydrates will be the result if standard cooking procedures are extended a simple by its cooking procedures are extended simply by in-creasing chemicals charge and time. There a sever-al options currently available: polysulfide pulping; anthraquinone additive; extended delignification; oxygen delignification; prenox treatment; alkaline leaching; and improved washing. All measures to reduce the residual lignin content of pulp prior to bleaching will positively affect almost all of the effluent characteristics. Most organochlorides are formed in the bleachplant, mainly as a result of the use of molecular chlorine in the first stage of bleaching. Some are formed in process water purification. Chlorine dioxide can be substituted for fication. Chlorine dioxide can be substituted for chlorine to a significant degree without detrimental effects on bleached pulp quality. Chlorine dioxide produces significantly less organochlorine compounds than chlorine. A prerequisite for efficient effluent treatment is that effluent volumes are kept as low as possible. The overall production cost will increase when applying internal pollution abatement options. The marginal addition is, however, small. (See also W91-11467) (Mertz-PTT)

EFFECTS OF CHLORINATION CONDITIONS ON THE AOX AND CHLORINATED PHENOL CONTENT OF KRAFT BLEACH PLANT WASTEWATERS.
Forest Research Inst., Rotorua (New Zealand). For primary bibliographic entry see Field 5D. W91-11474

BIOLOGICAL BLEACHING OF WOOD PULPS-A VIABLE CHLORINE-FREE BLEACHING TECHNOLOGY. Pira, Leatherhead (England). Paper and Board

N. Kirkpatrick.

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 75-79, 1991. 15 ref.

Descriptors: \*Biological treatment, \*Bleaching, Descriptors: "Biological treatment, "Pieacning, Enzymes, "Microorganisms, "Pulp and paper in-dustry, "Water pollution prevention, Biobleaching, Bleaching wastes, Chlorinated hydrocarbons, Mu-tagenicity, Toxicity.

Biobleaching of wood pulp is bleaching caused by the activity of certain microorganisms. The term biobleaching is sometimes also used to describe enzymatic bleaching. In both cases, the aim is to effect bleaching without the use of chlorine, thus minimizing the discharge of potentially toxic and mutagenic chlorinated organics in bleach plant effluents. The current status of biobleaching research is reviewed. On the basis of published information, biobleaching seems unlikely to entirely replace chlorine in a standard bleaching sequence. Therefore, biobleaching, like other alternative strategies such as extended delignification and oxygen bleaching may provide another means of decreasing the load of chlorinated organics in bleach plant effluents. Enzymatic bleaching holds greater promise than whole cell biobleaching. Hemicellulases used in conjunction with alkaline extraction have already been shown to result in significant savings. already been shown to result in significant savings. aiready been shown to result in significant savings.

A Finnish company has run tests on a 1000 metric ton scale in which enzymatic bleaching was shown to economically decrease chlorine consumption by 25-50%. More research is necessary to relate chlorine savings with decreases of bleach plant effluent toxicity and mutagenicity. (See also W91-11467) (Mertz-PTT)

CLOSING PAPER MILL WHITEWATER CIR-CUITS BY INSERTING AN ANAEROBIC STAGE WITH SUBSEQUENT TREATMENT.

Papiertechnische Stiftung fuer Forschung und Ausbildung in Papiererzeugung und -Verarbeitung, Munich (Germany, F.R.). Wasser- und Abwasserforschungsstelle.

R. Huster, I. Demel, and A. Geller. Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 81-90, 1991. 9 fig, 9 ref.

Descriptors: \*Anaerobic digestion, \*Pulp and paper industry, \*Pulp wastes, \*Wastewater treatment, \*Water pollution prevention, \*White water, Biological treatment, Industrial wastes, Model studies, Waste paper, Waste reduction, Water qualities of the page 1. ity control.

In the past few years, the paper industry has been able to significantly reduce the specific amount of effluent it produces. It is considered that the standeffluent it produces. It is considered that the stand-ard now achieved is not susceptible to improve-ments without a loss of product quality. The prob-lem substances imported with raw materials will tend to increase the specific amount of effluent produced by paper mills that process waste paper, and it will only be possible to operate completely and it will only be possione to operate completely closed circuits in exceptional cases. Integrating a biological purification plant into the whitewater circuit can help to solve this problem, which is specific to waste paper. Operating a purification plant in the half-stuff production sector makes it possible to achieve substantially lower quantities of specific effluent even in integrated paper mills if the water circuits for half-stuff production and for the water circuits for half-stuff production and for the papermachine are kept largely separate, and if the freshwater intake is effected via the paperma-chine's circuit. The use of anaerobic technology, with appropriate subsequent treatment if necessary, appears suitable because of its favorable energy balance. The possibilities and limits of using anaerobic technology for treating highly concentrated effluents from paper mills are largely known. The use of this technology in the whitewater circuits of paper mills is still in the planning stage. Simple model calculations can be used to estimate the effects of operating a purification plant on the equilibrium concentrations in the whitewater circuit and to detect possible problems. (See also W91-11467) (Author's abstract) (Mertz-PTT)

## FUTURE PERSPECTIVES FOR THE ANAERO-BIC TREATMENT OF FOREST INDUSTRY WASTEWATERS

Agricultural Univ., Wageningen (Netherlands). Dept. of Water Pollution Control. For primary bibliographic entry see Field 5D. W91-11478

DECREASE OF POLLUTANT LEVEL OF BLEACHING EFFLUENTS AND WINNING VALUABLE PRODUCTS BY SUCCESSIVE FLOCCULATION AND MICROBIAL GROWTH.

Goettingen Univ. (Germany, F.R.). Forstbotanisches Inst. For primary bibliographic entry see Field 5D. W91-11488

## ENVIRONMENTALLY DESIRABLE APPROACHES FOR REGULATING EFFLUENTS FROM PULP MILLS,

Sprague Associations Ltd., Guelph (Ontario). J. B. Sprague.

Water Science and Technology WSTED4, Vol. 24, No. 3/4, p 361-371, 1991. 4 tab, 31 ref.

Descriptors: \*Environmental policy, \*Environmental protection, \*Pulp wastes, \*Regulations, \*Wastewater outfall, \*Water pollution control, Australia, Chlorinated hydrocarbons, Discharge limits, England, Finland, Sweden, Toxicity, United States

An overall strategy of regulation should always include three tactics: (1) discharge limits at the end include three tactics: (1) discharge limits at the end of the effluent pipe, based on a reasonable level of industrial technology; (2) water quality-based limits, strict enough to eliminate sublethal effects beyond a mixing zone; and (3) periodic ecological surveys to check the effectiveness of the first two approaches. Sets of increasingly restrictive Levels of Achievement should be formulated to provide steps for management. The final level should represent an ultimate goal of eliminating deleterious seeps for management. He mina level's mount repre-sent an ultimate goal of eliminating deleterious discharges, for example the effluent-free mill. Recent Australian regulations for kraft mills give a balanced blend of all three tactics. Federal require-ments in the U.S. also have the three tactics, with good water quality limits for sublethal toxicity, but a blind spot for organochlorines. Canadian federal regulations continue to focus only on tactic no. 1, with little acknowledgment of the receiving ecosystems, although some provinces add that. Both Sweden and Finland regulate by discharge limits, Sweueri and Finiand regulate by discharge limits, but from a background of site-specific knowledge and needs. There are relatively uniform sites in the Baltic for Swedish mills, but a diversity of freshwater locations for Finnish ones. (See also W91-11467) (Author's abstract) W91-11504

## RISE AND FALL OF THE POTOMAC RIVER STRIPED BASS STOCK: A HYPOTHESIS OF THE ROLE OF SEWAGE.

Maryland Univ., Solomons. Chesapeake Biological

For primary bibliographic entry see Field 5C. W91-11529

## TOXICS REDUCTION: THE LEGAL FRAME-

McNees, Wallace and Nurick, Harrisburg, PA. For primary bibliographic entry see Field 6E. W91-11538

## NEW STORM WATER REGULATIONS REQUIRE SIGNIFICANT COMPLIANCE ACTIONS BY BOTH INDUSTRIES AND MUNICI-

BCM Engineers, Inc., Plymouth Meeting, PA. For primary bibliographic entry see Field 5D. W91-11541

## TOXICITY REDUCTION EVALUATIONS (TRE'S) AS A TOOL FOR MEETING EFFLUENT STANDARDS, TOXICITY

For primary bibliographic entry see Field 6E. W91-11542

## ESTIMATION OF SPORT FISH HARVEST FOR RISK AND HAZARD ASSESSMENT OF ENVIRONMENTAL CONTAMINANTS,

Battelle Pacific Northwest Labs., Richland, WA. T. M. Poston, and D. L. Strenge.
Available from the National Technical Information Avanaole from the National Technical Information Service, Springfield, VA. 22161, as DE89-011210. Price codes: A03 in paper copy, A01 in microfiche, Report No. PNL-SA-16365, January 1989. 28p. 1 fig. 7 tab, 45 ref. DOE Contract DE-AC06-76RLO 1830.

Descriptors: \*Sport fishing, \*Risk assessment, \*Ecological effects, \*Path of pollutants, \*Fish harvest, Recreation, Public health, Toxicity, Sunfish, Bass, Fish populations, Bioaccumulation, Food chain, Lipids, Fish, Muscle.

Consumption of contaminated fish flesh can be a significant route of human exposure to hazardous chemicals. Estimation of exposure resulting from the consumption of fish requires knowledge of fish consumption and contaminant levels in the edible portion of fish. Realistic figures of sport fish harvest are needed to estimate consumption. Descrip-tive statistics based on fishing pressure were de-rived from harvest data for four distinct groups of freshwater sport fish in three water types: streams, lakes, and reservoirs. Statistics were also developed for all fish harvested from a single site. Regression equations were developed to relate har-vest to surface area fished, where databases were sufficiently large; using the bioaccumulation factor and the concentration of contaminants in water as and the concentration of contaminants in water as variables in the exposure equation may also lead to less precise estimates of tissue concentration. Harvest estimates were developed for all species harvested and for 4 distinct groups of sport fish: bass, sunfish, trout, and catfish. Mean harvest rates for all species combined ranged from 0.575 fish/hr in cold water streams to 0.934 fish/hr in warm water traces. cold water streams to 0.934 hish/hr in warm water streams. The majority of trace metals are biologically available in water at low concentrations (ppb to low ppm) because they have a strong propensity to sorb to sediment and suspended material, or to form complexes with inorganic ligands. Generally, trace metals exhibit little tropism for fish muscle. Only Cr and Hg have shown an age-dependent increase in fish tissue concentration from samples increase in fish tissue concentration from samples collected in the field. Mercury is perhaps the only metal that has shown a propensity to accumulate in egible portions of fish and it has therefore been of great concern in Japan, Sweden and elsewhere. The influence of percentage of body lipids has been raised as a significant factor when estimating bioaccumulation factors in fish. Certain species of fish tend to contain more limit then others: however, the property of the contain more limit then others: however, the contain more limit then others however. bloaccumulation factors in itsh. Certain species or fish tend to contain more lipid than others; howev-er, the fish's breeding rate, the caloric content of its food, its age, and its physiological status will affect its lipid reserves. Generally, mean lipid levels for freshwater fish fillets range from 0.2 to nevers for treshwater fish fillets range from 0.2 to 7.7. Methods based on normalized bioaccumulation factors, maximum permissible tissue concentrations and percentage lipid in fish tissue have been proposed by the US EPA to determine acceptable tissue residue levels for fish. (Lantz-PTT) W91-11556

SUPERFUND RECORD OF DECISION: INTEL (MOUNTAIN VIEW), CA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-117037.
Price codes: A05 in paper copy, A01 in microfiche.
Report No. EPA/ROD/R-09-89/031, March 1989. 95p, 4 fig, 4 tab, 2 append.

Descriptors: \*California, \*Cleanup operations, \*Intel Site, \*Site remediation, \*Superfund, \*Volatile organic compounds, \*Water pollution sources, Air stripping, Costs, Groundwater pollution, Industrial wastewater, Monitoring, Phenols, Soil contamination, Tetrachloroethylene, Toluene, Trichlorothylene, Trichloroethylene, Waste capping, \*Lichloroethylene, \*Lichloroethylene, \*Lichloroethylene, \*Lichloroethylene, \*

## Water Quality Control-Group 5G

The Intel (Mountain View Plant) site is one of three Superfund sites in the Mountain View, Cali-fornia, area that are being remediated concurrent-ly. Various industrial activities were conducted in ly. Various industrial activities were consumed the vicinity of the site, including semiconductor the vicinity of the site, including semiconductor manufacturing, metal finishing operations, parts cleaning, aircraft maintenance, and other activities requiring the use, storage, and handling of a variety of chemicals, particularly solvents. Site investingations at several of these facilities during 1981 and 1982 revealed significant soil and groundwater contamination by toxic chemicals, primarily volatile organic compounds (VOCs). The primary causes of the contamination were leaking storage tanks and lines, and poor management practices. tanks and lines, and poor management practices. Before and during additional site investigations, which were conducted under a 1985 Consent Order, interim cleanup actions were conducted at the site by Fairchild, Intel, and Raytheon. These the site by Fairchild, Intel, and Raytheon. These included tank removals, soil removal and treatment, well sealing, construction of slurry walls, and hydraulic control and treatment of local groundwater. The primary contaminants of concern affecting the site are VOCs including trichlor-oethylene, trichloroethane, tetrachloroethylene, toluene, and xylenes; and other organics including phenols. The selected remedy for this site includes in situ vapor extraction with treatment by vapor hasse granular activated earbox (GAC) of conin situ vapor extraction with treatment of vapor phase granular activated carbon (GAC) of contaminated soil found within the Fairchild and Raytheon slurry walls. There may be some limited soil excavation and treatment by aeration for some areas outside of the slurry walls with on-site disareas outside of the slurry walls with on-site dis-posal of residues in the excavated area; groundwat-er pumping and treatment using air stripping, and in some cases liquid phase GAC, with emissions controls consisting of GAC vapor phase carbon units, followed by reuse of the groundwater (reuse options including reinjection are being developed) and if necessary discharge to surface water, sealoptions including temperation are being everloped) and, if necessary, discharge to surface water; sealing of any conduits or potential conduits to protect the deep aquifer; and groundwater monitoring. The present worth cost for this remedial action is \$49,000,000 to 56,000,000, which includes operation and maintenance costs. (Author's abstract)
W91-11581

## SUPERFUND RECORD OF DECISION: WHIT-MOYER LABORATORIES, PA.

MOYER LABORATORIES, PA. Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response. Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-114661. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/ROD/R03-89/075, June 1989. 46p, 3 fig, 3 tab, append.

Descriptors: \*Cleanup operations, \*Pennsylvania, \*Site remediation, \*Superfund, \*Whitmoyer Lab-oratories Site, Arsenic, Biodegradation, Costs, Groundwater pollution, Heavy metals, Landfills, Tetrachloroethylene, Volatile organic compounds, Wastewater treatment, Water pollution treatment.

The 22-acre Whitmoyer Laboratories site is located in Jackson Township, Lebanon County, Pennsylvania. Land use surrounding the site is predominantly agricultural; however, there is some residential, commercial, and industrial development within 1.5 miles of the site. This includes a manufacturing plant to the south; a pharmaceutical fac-tory to the east; a large, active limestone quarry to tory to the east, a large, active innessione quarry to the west; and an elementary school to the north-west of the site. Portions of the site are within neighboring Tulpehocken Creek's 100-yr flood-plain. In 1957 site owners began producing organic arsenicals at the site. In 1964 widespread groundwater contamination was discovered on-site lead-ing to the placement of concentrated wastes in a concrete vault and the initiation of groundwater pumping and treatment. Sludges from the groundpumping and treatment. Sludges from the ground-water treatment were later consolidated in lagoons. In 1987 an EPA investigation revealed that ap-proximately 69,000 gallons of concentrated liquids had been abandoned on-site in 18 tanks and 14 piping units. The wastes include 5,000 gallons of water-immiscible liquids, 25,000 gallons of water-miscible liquids with a high arsenic content, and 39,000 gallons of water-miscible liquids with a low arsenic content. Flooding of the creek could cause failure of these tanks, resulting in a catastrophic failure of these tanks, resulting in a catastrophic

### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

## Group 5G-Water Quality Control

release of contaminants to the creek. Because the concentrated liquids pose significant health and environmental threats, their removal is addressed in this first operable unit. The primary contami-nants of concern in the concentrated liquids are nants of concern in the concentrated liquids are volatile organic compounds including tetrachlor-oethylene, and metals including arsenic. The selected interim remedial action for this site includes consolidating and transporting off-site, and then treating, using thermal treatment or biodegradation, or recycling approximately 69,000 gallons of concentrated liquid wastes at a permitted Resource Conservation and Recoveryr Act (RCRA) facility, followed by disposing of treated water in off-site surface water and disposing of solid residues in an off-site landfill; decontaminating 32 tanks and approximately 2,000 ft of piping to meet RCRA out-site landfill; decontaminating 32 tanks and approximately 2,000 ft of piping to meet RCRA Subtitle C closure standards and disposing of the tanks and piping on-site; and treating and disposing of the cleaning agent residues off-site at RCRA-permitted facilities. The estimated capital cost of this interim remedial action is \$475,000, with no operation and maintenance costs. (Lantz-PTT) W91-11582

STATUS REPORT ON REMEDIAL INVESTI-GATION OF THE 300 AREA PROCESS PONDS. GATION OF THE 300 AREA PROCESS PONDS, Battelle Pacific Northwest Labs., Richland, WA. D. I. Dennison, D. R. Sherwood, and J. S. Young. Available from the National Technical Information Service, Springfield, VA. 22161,as DE90-003667. Price codes: A05 in paper copy, A01 in microfiche. Report No. PNL-6442, September 1989. 75p, 14 fig. 10 tab, 5 ref, 2 append. DOE Contract No. DE-AC06-76RLO 1830.

Descriptors: \*Pollutant identification, \*Process ponds, \*Remedial investigation, \*Site remediation, \*Water pollution sources, Aluminum, Cesium radioisotopes, Chromium, Cobalt radioisotopes, Copper, Heavy metals, Nickel, Organic compounds, Path of pollutants, Polychlorinated biphenyls, Sediment contamination, Silver, Zinc.

A remedial investigation (RI) of the South and North Process Ponds adjacent to the 300 Area at the US Department of Energy (DOE) Hanford Site was initiated in FY 1987 as partial implementation of the DOE Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Program. The objective of FY 1987 activities was initial characterization of the quantity and distribution of contaminants in the active and distribution of contaminants in the active. ty and distribution of contaminants in the sedi-ments. Sediment samples from 14 locations in and adjacent to the ponds were collected and analyzed. Initial results indicated that contaminated sediments in the ponds typically contained Ag, Al, Cr, Ni, and Zn that were elevated relative to background levels. Radiochemical analyses of the sediments showed that the primary radiological contaminant was uranium; 60-Co and 137-Ce were detected in several samples. Future RI activites will be undertaken under EPA-approved RI/FS work plans. (Author's abstract) W91-11583

ASSESSMENT OF INTERNATIONAL TECHNOLOGIES FOR SUPERFUND APPLICA-

Environmental Protection Agency, Washington, DC. Office of Solid Waste and Emergency Re-

sponse.

Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-106428. Price codes: A05 in paper copy, A01 in microfiche. Report No. EPA/540/2-88/003, September 1988. 50p, 1 fig. 4 tab, 13 append. EPA Contract No. 68-03-3243.

Descriptors: \*Cleanup operations, \*Site remediation, \*Superfund, \*Water pollution treatment, Air stripping, Belgium, Biological treatment, Cadmium, Chemical treatment, Electrochemistry, Extraction, Germany, In situ treatment, Incineration, Technology, The Netherlands.

Several international technologies were identified and investigated for their applicability to hazard-ous waste site remediation in the United States. The program was conducted in two phases: Phase I involved technology identification and selection;

Phase II was an investigation of the most promis-ing technologies identified in Phase I. This report summarizes the results of Phase II. The field team visited with twelve research groups, consultants and manufacturers at 15 locations in The Netherlands, Belgium and the Federal Republic of Ger-many. Results of the individual site visits are summany. Results of the individual site visits are sum-marized and a capsule summary of each technolo-gy includes a brief process description, discussion of process levelopment. In general, the Phase II efforts were successful at identifying site cleanup technologies not currently used in the United States, as well as unique applications of techniques used in the United States. Among the most important Phase II findings were five differ-ent soil washing techniques in Holland and Germa-ny. Another key finding was the High Tempera-ture Slagging Incinerator technology reviewed in Belgium. In addition, the field team reviewed unique applications of in situ biological treatment and composting techniques, vacuum extraction and and composting techniques, vacuum extraction and in situ air stripping, in situ extraction of cadmium from soils, application of rotating biological contractors, and electrochemical dehalogenation techniques. niques. (Author's abstract) W91-11584

PRELIMINARY DATA SUMMARY FOR THE MACHINERY MANUFACTURING AND REBUILDING INDUSTRY.

Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards. For primary bibliographic entry see Field 5B. W91-11589

NUTRIENT LOADING STATUS OF THE CON-ESTOGA RIVER BASIN, 1985-1989. Susquehanna River Basin Commission, Harrisburg, PA. Resource Quality Management and Protection

A. N. Ott. Susquehanna River Basin Commission, Harrisburg, Pennsylvania. Publication No. 133, April 1991. 14p. 4 fig. 3 tab.

Descriptors: \*Conestoga River Basin, \*Nutrients, \*Pennsylvania, \*Phosphorus, \*Pollutant load, \*Water pollution cources, Monitoring, Municipal wastewater, Nitrogen, Stream discharge.

The Conestoga River at Conestoga, PA, one of 14 Pennsylvania sites monitored by the Susquehanna River Basin Commission for its nutrient loading content from 1985 to 1989, was the only site to show a significant change in loading. Annual nitrogen loads indicated a good relationship (no change in loading) with the mean annual stream discharge, while the phosphorus load for 1988 and 1989 showed a decreased loading. Monthly base flow phosphorus concentrations were significantly lower during June 1988 to December 1989 than for the January 1985 to May 1988 period. Records provided from the City of Lancaster, PA sewage treatment plant (STP) showed substantial reduction in phosphorus effluent loadings in 1988 and 1989 in contrast to the loadings of prior years. Conestoga River phosphorus load reduction in 1988, but the STP reduction in 1989 accounted for only a part of the 1989 river reduction. (Author's abstract)

### 6. WATER RESOURCES PLANNING

## 6A. Techniques Of Planning

INTERNATIONAL AND TRANSBOUNDARY WATER RESOURCES ISSUES. For primary bibliographic entry see Field 6E. W91-11003

GREAT LAKES CHARTER: POTENTIAL AND

New York State Public Services Commission, Albany. For primary bibliographic entry see Field 6E.

WHAT MAKES REGIONAL ORGANIZATIONS SUCCEED OR FAIL.

Harvard Energy and Environmental Policy Center, Cambridge, MA. C. H. W. Foster.

In: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 11-18, 8 ref.

Descriptors: \*Interstate compacts, \*New England, \*Water resources management, Environmental impact, Jurisdiction, Massachusetts, Water resources development.

In a series of three workshops, convened in May of 1987 with the assistance of the Fund for New England and the Massachusetts Foundation for Humanities and Public Policy, 60 New England theorists and practitioners gathered to compare notes on what makes regional institutions succeed or fail. The participants determined the elements of success or failure to fall within four categories: (1) how a region is defined (boundaries and dimensions of a given region); (2) how a region is formed (natural resources and environmental issues); (3) what a region does (how successful the region (natural resources and environmental issues); (3) what a region does (how successful the region carries out its programs); and (4) how a region feels about itself (quality characterized as a distinctive sense of place). (See also W91-11003) (Lantz-W91-11005

CHANGING DYNAMICS OF INTEREST REP-RESENTATION IN WATER RESOURCES MANAGEMENT.

University of Western Ontario, London. Dept. of Geography.

For primary bibliographic entry see Field 6E.

LEGAL REGIMES FOR INTERSTATE WATER ALLOCATION IN THE WESTERN UNITED STATES: SOME SUCCESSES AND FAILURES. New Mexico Univ., Albuquerque. School of Law. For primary bibliographic entry see Field 6E. W91-11008

REGIONAL APPROACH TO DROUGHT PLANNING AND MANAGEMENT IN THE GREAT LAKES BASIN.

Great Lakes Basin Commission, Ann Arbor, MI. T. R. Crane, R. C. Damberg, and M. J. Donahue. IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 79-91, 2 fig,

Descriptors: \*Drought, \*Great Lakes, \*Interna-tional agreements, \*Interstate compacts, \*Water resources management, Data acquisition, Illinois, Indiana, Information exchange, Interstate commis-sions, Michigan, Minnesota, Monitoring, New York, Ohio, Ontario, Pennsylvania, Quebec, Water deficit, Wisconsin.

The 1988 drought caused the international Great Lakes Basin to suffer losses in agricultural produc-tivity, increased public costs, and the economic and environmental consequences of lowered water levels and water scarcity. The crisis response situalevels and water scarcity. The crisis response situation prompted numerous state, provincial, and federal legislative policy initiatives and emergency programs. Current policies and programs in many areas touched by the drought were called into question, and the debate over Great Lakes water diversion was renewed. The Great Lakes Commission established drought management as a priority issue in November 1988 in response to the impacts of that year's drought on various sectors of the Great Lakes economy and environment. A project to assist local, state, provincial, and federal officials in establishing a coordinated, regional planning in establishing a coordinated, regional planning framework for drought management was proposed

## Techniques Of Planning-Group 6A

at the Commission's Annual Meeting on November 10, 1988. The first action taken by the Great Lakes Commission in the area of drought management was to create a Drought Management and Great Lakes Water Levels Task Force. Members of the Lakes Water Levels Task Force. Members of the Task Force represent the eight states bordering the Great Lakes (MN, WI, IL, MI, OH, PA, NY), the province of Ontario, and several federal agencies. Recommendations of the drought management task force were: (1) development of a Federal Drought Task Force; (2) development of State/Provincial task forces; (3) expanded data collection and dissemination; (4) increased monitoring of drought conditions and water levels; and (5) establishing intermediate and long-term planning activities. (See also W91-11003) (Lantz-PTT) W91-11012

APPLYING SUSTAINABLE DEVELOPMENT TO THE GREAT LAKES-EXPERIENCE AND OPPORTUNITIES UNDER THE BOUNDARY WATERS TREATY.
International Joint Commission-United States and Canada, Ottawa (Ontario).
For primary bibliographic entry see Field 6E. W91-11019

BREAKING THE INCREMENTALIST TRAP:
ACHIEVING UNIFIED MANAGEMENT OF
THE GREAT LAKES ECOSYSTEM.
Cornell Univ., Ithaca, NY. Dept. of Civil and
Environmental Engineering.
D. J. Allee, and L. B. Dworsky.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 213-227, 12

Descriptors: \*Ecosystems, \*Great Lakes, \*Institu-tions, \*International Joint Commission, \*Interna-tional commissions, \*Water resources manage-ment, Management planning, Public policy, Water

In normal times only small changes in policy can find agreement. Large changes generate too much uncertainty and objection to be adopted. But what is normally more than an incremental policy change can become incremental under crisis. The greater the sense of crisis the more it can be expected that there will be support to act and to ignore at least some objections that would become road blocks in normal times. Such policy change windows can be created by Great Lakes related events such as fish consumption bans or extreme water levels. A definition of the Great Lakes as an ecosystem and the application of that definition suggests the basis for the development of more policy windows as well as the current need for issue resolution. Nongovernmental organizations will play an important role but so will the states and provinces. Two incubation opportunities provide new and nonincremental opportunities to In normal times only small changes in policy can and provinces. Two incubation opportunities provide new and nonincremental opportunities to meet the challenge of devising means to manage the Great Lakes as an integrated ecosystem. The first incubator is structured around the current wide ranging effort of the International Joint Commission (IJC) and the carrying out of its responsibilities of the Great Lakes Water Levels Reference. The second incubation opportunity would have the creation of an Ecosystem Study Board be the outgrowth of a new study to gain a Great Lakes ecosystem perspective, per se, not tied to Lakes ecosystem perspective, per se, not tied to any issue but the need for such a perspective. The any issue but the need for such a perspective. The opportunity provided by the second incubator build on the strengths already in place or developing for managing a Great Lakes Integrated Ecosystem. Some of the strengths are: experience under the Great Lakes Water Quality Agreement; commitment to the ecosystem approach; perceptions and philosophies expressed by the IJC on the need for a broader Ecosystem approach; the wide range. for a broader Ecosystem approach; the wide rang-ing reports compiled by IJC task forces established by formal References on matters other than water quality identifying linkages to other issues; the accumulation of national and international arrangeaccumulation of national and international arrange-ments under quasi-formal or informal agreements among governments and non-governmental enti-ties; and, the capacity of modern computational equipment to model complex multi-objective and multi-functional problems. (See also W91-11003)

W91-11025

GREAT LAKES WATER LEVELS MANAGE-MENT: RELAXING THE 'POLICY TRAP'. Toronto Univ. (Ontario). Inst. for Environmental

A. P. Lino Grima.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 241-247, 15

Descriptors: \*Great Lakes, \*International Joint Commission, \*Water level, \*Water resources man-agement, Fluctuations, Political aspects, Public policy, Regulated flow, Resources management,

The current study of Great Lakes water levels presents an opportunity to examine policies that enhance resiliency and relax the 'social trap', i.e. the cyclical pattern of developing and protecting hazard-prone shoreline. Since 1964, the fluctuaitions of Great Lakes water levels have been the subject of four studies by the International Joint Commission (IJC). Previous studies have demonstrated that Great Lakes water levels are already efficiently regulated by nature; further efforts to control water levels are limited in scope and costly to implement. These technical findings are not likely to be drastically changed. Therefore, the political-education function of the current studies political-education function of the current studies assumes a special significance. The current study is being carried out in a context of uncertainty: some predict a reduction in average runoff of 20% due to climate change and a further reduction in water levels due to increased consumptive water uses. The context of uncertainty makes it even more important to from on extrateries to cope with the The context of uncertainty makes it even more important to focus on strategies to cope with the fluctuations in water levels rather than regulate them. A suggested comprehensive approach to reduce flood and erosion damage would include mapping hazard-prone shorelines as a basis for land use regulations backed by economic incentives and legal penalties. An appropriate split of jurisdictional responsibilities is required. (See also W91-11003) (Author's abstract)

REGULATION OF LAKE ONTARIO LEVELS. Corps of Engineers, Buffalo, NY. Water Quality

In: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 249-258, 2 fig.

Descriptors: \*Great Lakes, \*Lake Ontario, \*Regulated flow, \*Water resources management, Decision making, Great Lakes/St Lawrence River Basin, Management planning.

During the past 30 yrs, the Great Lakes have experienced periods of drought and high water. Throughout this time, the levels of Lake Ontario have responded to these climatic changes and have been modified by regulation. The present regulation plan for Lake Ontario is referred to as Plan notes that the present regulation of the present regulation plan for Lake Ontario is referred to as Plan. 1958-D. The plan specifies outflows which are subject to various criteria and limitations in order subject to various criteria and immandis in order to provide overall benefits to interests throughout the Lake Ontario/St. Lawrence River basin. A degree of discretion is also included among the plan criteria to enable response to conditions outside the range upon which the plan was developed. Recent high and low supply conditions have resulted in much concern regarding the plan's re-Recent high and low supply conditions have re-sulted in much concern regarding the plan's re-sponsiveness. As a result, the plan is being critical-by reviewed with the objective of establishing a new method which would respond more quickly to changing supplies and address interests not pre-viously considered. The final outcome of this viously considered. The final outcome of this review will most likely be a dynamic regulation procedure: a combination of a regulation plan guided by hydrologic-based forecasting models. The procedure will be 'dynamic' in that it will be flexible to the incorporation of future regulation improvements and operational experience. Discretionary actions will be formalized to some degree, however, they cannot be eliminated since future

supply conditions will likely remain unknown. (See also W91-11003) (Lantz-PTT) W91-11028

SUCCESSES AND CHALLENGES IN DEVELOPING AND IMPLEMENTING REMEDIAL ACTION PLANS TO RESTORE DEGRADED AREAS OF THE GREAT LAKES.

International Joint Commission-United States and Canada, Windsor (Ontario).

J. H. Hartig, L. Lovett-Doust, and P. Seidl IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 269-278, 1 fig,

Descriptors: \*Great Lakes, \*International Joint Commission, \*Lake restoration, \*Remedial Action Plans, \*Water pollution control, \*Water resources management, International commissions, Management planning, Resources management, Water quality control.

Forty-two Areas of Concern have been identified in the Great Lakes Basin Ecosystem where general or specific objectives of the Great Lakes Water Quality Agreement are not met and where such failure has caused or is likely to cause impairment of beneficial use or of the area's ability to support aquatic life. The eight Great Lakes States and the aquatic life. The eight Great Lakes States and the Province of Ontario have committed to developing and implementing a Remedial Action Plan (RAP) to restore beneficial uses in each Area of Concern within their political boundaries. RAPs are to idenwithin their political boundaries. KAP's are to iden-tify when specific remedial actions are to be taken to resolve these problems, and who is responsible for implementing them, in an effort to increase accountability. The International Joint Commis-sion believes that successful remediation of Areas of Concern depends on the full and effective involvement of all stakeholders. Selected successes include enhanced cooperation and communication and greater emphasis on contaminant control at source, and assessment and remediation of con-taminated sediments. Remaining challenges include limited resources, a need to assign responsibility for remedial actions, and the need to integrate RAPs into state, provincial and federal priorities. (See also W91-11003) (Author's abstract) W91-11030

SOCIO-ECONOMIC CONSIDERATIONS IN REMEDIAL ACTION PLANNING FOR THE GREAT LAKES—A CASE STUDY FOR SUSTAINABLE DEVELOPMENT.

Canada Centre for Inland Waters, Burlington (Ontario).

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 279-287, 4 ref.

Descriptors: \*Economic aspects, \*Great Lakes, \*Lake restoration, \*Ontario, \*Remedial Action Plans, \*Social aspects, \*Water pollution control, \*Water resources management, Canada, Case studies, Management planning, Provincial jurisdiction, Public policy, Water resources development.

Early in the process of remedial action planning (RAPs), it was recognized that socio-economic considerations would be a necessary component of any completed plan involving public expenditures. any completed plan involving public expenditures.

A discussion document on socio-economics in RAPs was produced and released to the 17 Canadian RAP coordinators to encourage them to include socio-economic studies apart of the planning process. To date, socio-economic studies have been conducted for two Access of Comment Facility. been conducted for two Areas of Concern, Hamil-ton and Bay of Quinte, and an economic overview of the entire RAP process in Canada-Ontario is being conducted by the provincial Ministry of the being conducted by the provincial Ministry of the Environment. Since the remedial measures will likely involve a sustainable redevelopment of the area extending beyond the water body, there is a need to consider RAPs from a broad ecosystem perspective including humans and societal activi-ties. Socio-economic information is crucial if pub-licly responsible and defensible decisions are to be made on these issues through the multi-disciplined/ made on these issues through the multi-disciplined/

### Field 6-WATER RESOURCES PLANNING

## Group 6A—Techniques Of Planning

interested stakeholder/public advisory process. Only two such studies have been completed so far, and these have met with resistance from the stakeholders to the RAP process. Reasons for this resistance need to be understood and addressed for any new studies. Benefit cost analysis should not be used for the consideration of RAP socio-economic desirability. Rather, a series of studies are needed that provide timely information to support the public involvement process leading to the prepara-tion and implementation of the RAP. Historical, current and past uses need to be identified in socioeconomic terms. Long-term sustainable use goals for the areas of concern need to be developed based on the social and economic consequences of redevelopment. Timely and cost-effective imple-mentation of the remedial actions, from a societal perspective, needs to be identified for implementation. Finally, there is a need to audit and revise the plans based on the degree to which the societal goals of the RAP are achieved. (See also W91-11003) (Lantz-PTT) W91-11031

FLUCTUATING GREAT LAKES WATER LEVELS: PROGRESS AND OPPORTUNITIES. International Joint Commission-United States and

International Joint Commission-United States and Canada, Ottawa (Ontario).

M. Clamen, and D. F. Parsons.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 289-297, 5 ref.

Descriptors: \*Fluctuations, \*Great Lakes, \*Great Lakes/St Lawrence River Basin, \*International Joint Commission, \*Water level, \*Water resources management, Ecological effects, Ecosystems, Environmental impact, International commissions, Political aspects, Public policy, Regulations.

On August 1, 1986, during a time of record high water levels on all the Great Lakes except Lake Ontario, the Governments of Canada and the United States requested the International Joint Commission (IJC) to examine and report upon Commission (IJC) to examine and report upon methods of alleviating the adverse consequences of fluctuating water levels in the Great Lakes-St. Lawrence River Basin. The IJC interpreted the Governments' request as requiring a more comprehensive study than had been undertaken in any of the previous IJC investigations on this topic. The Commission has responded to the Reference in a number of ways, including submission of initial letter reports to Governments in November and December 1986 an Interim Report in November. December 1986, an Interim Report in November 1988, and establishment of a Project Management Team (PMT) in June 1987 to undertake the first phase of this broad comprenensive study. In 1989 the Commission released reports produced during Phase I for public review and comment, the phase steaming for the final phase. Seven ase of this broad comprehensive study. In midand began planning for the final phase. Seven Annexes were prepared by the PMT's work groups; the Progress Report was drawn primarily from the Annexes, but with separate conclusions and recommendations. Additional findings, conclusions sions and recommendations are contained within the various Annexes and area those of the individual groups. The subjects of the seven Annexes are: Past and future water level fluctuations; Environmental features, processes and impacts-an ecosystem perspective on the Great Lakes-St. Lawrence River System; Interests, policies and decision making-prospects for managing the water level issues in the Great Lakes-St. Lawrence River Basin; The Great Lakes ecosystem perspective implications for water level management; Potential actions to deal with the adverse consequences of fluctuating water levels; Evaluation instrument; and, Public information program. (See also W91-11003) (Lantz-PTT) W91-11032

LIMITS OF GOVERNMENT RESPONSIBIL-

ITY. Virginia Polytechnic Inst. and State Univ., Blacksvargania ronyectanic last, and State Univ., Bl burg. Dept. of Agricultural Economics. For primary bibliographic entry see Field 6E. W91-11034

WHAT STAKEHOLDERS WANT AND WHY.

Gore and Storrie Ltd., Toronto (Ontario). L. Ludlow, and K. O'Grady. IN: International and Transboundary Water Re-

sources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 319-328, 1

Descriptors: \*Institutional constraints, \*Public participation, \*Water resources management, \*Water use, Cost-benefit analysis, Costs, Land use, Regula-

Interests make investments in order to capture flows of services from the lakes and/or the channels of the Great Lakes Basin. In so doing, the interests employ expectations of how future events are likely to affect future welfare. These expectations form the basis of the positions held by the interest and, as such, provide an impetus behind petitioning for government action. Petitioning can arise from a number of sources including: (1) surject Dake of resiliency. (3) cost shifting, and (4) arise from a number of sources including: (1) sur-prise, (2) lack of resiliency, (3) cost shifting, and (4) benefit enhancement. In examining the interests' positions, several main points emerge. Surprise and lack of resiliency appear to underlie much of the petitioning. Considerable disagreement exists be-tween and within groups as to the desirability of level regulation measures. Any action initiated by a level of government to address the issue of fluctua-tions, including the decision to do nothing, is de-fined as a measure. The five broad classes of measfined as a measure. The five broad classes of measures which governments could implement to address the fluctuating water levels issue are: Type 1--regulation and diversion; Type 2--direct government investment for adoption and protection (e.g. shore protection works); Type 3-direct restrictions on land and water use (e.g. set back and zoning requirements, ship navigation procedures); Type 4-programs to indirectly influence use (e.g. aype --programs to indirectly influence use (e.g. hazard mapping, information and education programs); and Type 5--emergency response. Aside from those interests seeking level regulation, most interests either petition for maintenance of the status quo or seek more localized measures. There status quo or seek more localized measures. I nere is no unified support for any particular localized measure except, perhaps, a broad support for measures providing a variety of information. (See also W91-11003) (Lantz-PTT) W91-11035

INSTITUTIONAL MORASS: CONSTRAINTS AND OPPORTUNITIES FOR ISSUE MANAGE-

AND OPPORTUNITIES FOR ISSUE MANAGE-MENT.
National Oceanic and Atmospheric Administra-tion, Ann Arbor, MI. Great Lakes Environmental Research Lab.
H. C. Hartmann, and M. J. Donahue.
IN: International and Transboundary Water Re-sources Issues. American Water Resources Asso-ciation, Bethesda, Maryland, 1990. p 329-338, 9 ref.

Descriptors: \*Decision making, \*Great Lakes, \*Institutional constraints, \*International Joint Commission, \*Water resources management, Governmental interrelations, Water level.

The complex institutional setting for Great Lakes governance is a reality that must be accommodated in any attempt to improve management of Great Lakes water level issues. Efforts to establish meas-Lakes water level issues. Efforts to establish measurable goals and objectives for institutions, systems of accountability, performance evaluation procedures, and mechanisms to withdraw marginal institutions, have more potential for improving institutional effectiveness than creation of any new, omnipotent regional authority. A critical shortcoming of the present institutional setting is the lack of established forums for alternatives dispute resolution (ADP) processes that can forter returnal learn tion (ADR) processes that can foster mutual learning among interest groups, including government agencies. For disputes with a strong technical dimension, ADR uniquely offers the potential for groups to change their positions based on learning that occurs through direct dialogue with other groups. Commitment to use ADR processes as a first approach for managing disagreements over water level issues does not require additional International Joint Commission (IJC) authority; existing provisions of the Boundary Water Treaty of 1909 are sufficient. For local water level issues. effective tion (ADR) processes that can foster mutual learnare sufficient. For local water level issues, effective forums could be provided by federal, state/provincial, or regional agencies (interstate and intrastate)

provincial) that have no direct involvement in decision making concerning the specific issue, or by non-governmental organizations that have broad resource management interests and are capable of impartial and independent functions. (See also W91-11003) (Lantz-PTT)
W91-11036

SO WHAT, FINDINGS AND RECOMMENDA-TIONS FROM THE LAKE LEVELS STUDY. Virginia Polytechnic Inst. and State Univ., Blacks-burg. Dept. of Agricultural Economics. L. Shabman, and B. Smit.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 339-348, 2 ref.

Descriptors: \*Government interrelations, \*Great Lakes, \*Institutional constraints, \*Water level, \*Water resources management, Communication, Decision making, Information exchange, Public

The recommendations presented in the paper evolve from findings relating to the positions of the interests, policies of governments, and institutional organizations and decision making processes; they organizations and decision making processes; they are addressed to the federal governments. In general, governments must improve their ability to inform interests, both about the nature of the physical system and about the policies and programs to direct use of the basin's resources. More specifically, governments should clarify and articulate their course respecibilities, define and develop appropria 19, governments should charry and articulate their own responsibilities, define and develop appropriate information bases, and establish and commit to the use of vehicles for improved communication between interests. Communications can be facilitated using Alternative Dispute Resolution (ADR) procedures within the confines of the Boundary aters Treaty as it stands at present. Governments should also make clear that measures to regulate levels are unlikely to be implemented in the fore-seeable future. (See also W91-11003) (Author's abstract) W91-11037

WATERSHED YEARS AT NIAGARA FALLS: CANADIAN AND AMERICAN POLICY RE-SPONSES TO NEW MEANINGS OF POWER,

California Univ., Santa Barbara. Dept. of History. For primary bibliographic entry see Field 6E. W91-11038

MILK RIVER: HISTORICAL TRANSITIONS IN AN INTERNATIONAL WATERWAY.
Montana State Univ., Bozeman. Water Resources

Research Center. For primary bibliographic entry see Field 6E. W91-11039

INTERPROVINCIAL WATER MANAGEMENT IN WESTERN CANADA.

Prairie Provinces Water Board, Regina (Saskatchewan).

For primary bibliographic entry see Field 6E. W91-11040

COMPARATIVE WATER MANAGEMENT: A TALE OF TWO COMPACTS.

Central Michigan Univ., Mount Pleasant. Dept. of Business Law and Regulation. J. P. Hill.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 393-404, 13

Descriptors: \*Great Lakes, \*Interstate compacts, \*Water resources management, Case studies, Delaware River Basin, Interstate commissions, Political aspects, Regulations, Water resources develop-

It has become increasingly clear that the Great Lakes Basin needs some kind of effective and enforceable comprehensive water management plan

## **Evaluation Process—Group 6B**

if it is to effectively stave off growing water diver-sion and pollution threats to the integrity of the Lakes. One of the primary barriers to development of a comprehensive plan for managing the water resources the Great Lakes, has been a lack of 'political will' on the part of the member states. While informal, cooperative water resources manwhite infolmai, cooperative water resources man-agement efforts are being undertaken to develop such a program, valuable political lessons can be gained by examining the development of the formal federal-interstate regulatory compact used to manage the Delaware River Basin. Several fac-tors seem to have led to the formation of the tors seem to have led to the formation of the federal-interstate compact governing the Delaware River Basin. But, as one expert on the Delaware River Basin Compact stated, the primary ingredients for creating institutions such as the Delaware River Basin Compact are time and political will. The alleged lack of political will in the Great Lakes region, which apparently resulted in the formation of a weak Great Lakes Commission, may in part be attributed to a lack of consensus as to what type of institutional arrangement would be may in part be attributed to a lack of consensus as to what type of institutional arrangement would be most appropriate for the various member states. This determination of the appropriate institutional framework for governing the Delaware Basin was not a problem because of an impressive plan for governmental organization of the Delaware River Basin. Many of the preconditions that helped marshall the necessary political will of the Delaware Basin to form a federal-interstate compact also exist in the Great Lakes Basin. Considering the historical similarities of the two basins, it is not inconceivable that some triggering event such as another drought and/or a new out-of-basin diveranother drought and/or a new out-of-basin diver-sion threat could serve as a catalyst to force movement away from the status quo arrangement of the existing Great Lakes Basin Compact. There is no legal barrier to including Canada as a signatory party to any compact; therefore Canada is a critical party to any comprehensive water resource management plan for the Great Lakes Basin. Fed-eral participation in a new or revised federal-interct may reduce the opposition to formal Canadian involvement that surfaced in the lengthy Congressional approval process of the existing Great Lakes Basin Compact. (See also W91-11003) (Lantz-PTT) W91-11042

COMPREHENSIVE WATER MANAGEMENT STRATEGY: CREDIT RIVER WATERSHED. Triton Environmental Consultants Ltd., Burnaby (British Columbia).

(Brussa Columbia). R. H. Tufgar, H. Whiteley, and H. Bretton. IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 405-418, 2 fig. 5 tab, 10 ref.

Descriptors: \*Credit River Basin, \*Water management, \*Water resources management, Environmental impact, Erosion, Fisheries, Flooding, Recreation, Water quality.

The Credit River Watershed is experiencing signif-Ine credit River watershed is experiencing significant urban growth which has created concerns regarding potential impacts on flood potential, erosion base flow and water quality. Water quality impacts could threaten the continuation of the existing cold water fisheries resource, water-based recreation activities, and environmentally sensitive areas. In order to preserve the integrity of the Credit River, the Credit Valley Conservation Authority carried out a study to develop a Water Management Strategy for the watershed. The study included a detailed technical assessment of the impacts of development on the flow regime characteristics and related impacts including flood potential, erosion potential and base flow. Environmental and public issues reviewed in the study were placed into three resource categories: (1) fisheries. (2) environment, and (3) recreation. The recreation activities, and environmentally sensitive were placed into three resource categories: (f) fisheries, (2) environment, and (3) recreation. The sensitivity of each category to hydrologic changes in the watershed was analyzed. This analysis indicated that although the sensitivity of the various resource areas varied, the areas of highest sensitiviresource areas varied, the areas of highest sensitivi-ty were distributed throughout the watershed. The areas of highest sensitivity for fisheries and envi-ronmental resources were primarily located in the upper watershed and central portions of the water-shed where development is not as concentrated.

Recreational areas exhibited the highest sensitivity Recreational areas exhibited the fighest sensitivity in the lower watershed where development is intense. The analysis of potential impacts of development on hydrologic regime, and in turn on flooding, erosion, base flows and environmental impacts, indicated that the impacts are interrelated. The requirements for storm water management The requirements for storm water management must consider all of the areas of impact investigated. Control of peak flow rates is required to avoid flood damage impacts, volume control is needed to mitigate erosion impacts, recharge is needed to avoid base flow reduction, and water quality control is needed for environmental concerns. (See also W91-11003) (Lantz-PTT)

MANAGING TRANSBOUNDARY WATER DI-VERSIONS: EXPERIENCE FROM A PRIVATE

Hackensack Water Co., Harrington Park, NJ. Research and Development Div P. C. Tao.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 429-438, 4 fig,

Descriptors: \*Diversion structures, \*Interbasin transfers, \*New Jersey, \*Water resources management, Hackensack River Basin, Reservoir operation, Reservoirs, Wanaque Reservoir.

The four-reservoir system in the Hackens The four-reservoir system in the Hackensack River basin is the main source of supply for the Hackensack Water Company (HWC) in New Jersey. Lake DeForest, the largest among the 4 reservoirs, is located in Rockland County, New York, the head water of the Hackensack River. The Spring Valley Water Company (SVWC), a sister utility serving Rockland County, also relies on Lake DeForest as its primary source for meeting its summer water. Rockland County, also relies on Lake DeForest as its primary source for meeting its summer water demand. Wanaque South Project is an interbasin water diversion project, capable of pumping up to 75 million gallons per day from the Wanaque Reservoir system in the Passaic River Basin to Hackensack. The Wanaque South Project is a joint venture between HWC and North Jersey District Water Supply Commission (NJDWSC). The NJDWSC, a New Jersey State water supply agent, provides wholesale water to the municipalities in Passaic and Essex Counties, New Jersey. This paper presents: (1) the regional water supply concept to manage the Lake DeForest release across the New York-New Jersey State boundary and settle the dispute between New York (SVWC) and New Jersey (HWC) on the operation of Lake DeForest during a drought; and (2) the reservoir storage and interbasin water transfer strategy to manage diversion across the franchise lines and manage diversion across the franchise lines and watershed boundaries, and to optimize the water supply resources for HWC and NJDWSC. (See also W91-11003) (Author's abstract) W91-11045

NEW YORK CITY'S DELAWARE RIVER BASIN SUPPLY—A CASE STUDY IN INTER-STATE COOPERATION—. New York City Bureau of Water Supply. For primary bibliographic entry see Field 6E. W91-11046

WATER MARKET IN THE SOUTHERN FRONT RANGE OF COLORADO.
Colorado Coll., Colorado Springs. Dept. of Economics and Business.

For primary bibliographic entry see Field 6D. W91-11055

COORDINATING ROLES AND SERVICES: SOIL CONSERVATION SERVICE AND EX-TENSION SERVICE.
For primary bibliographic entry see Field 6E.
W91-11171

DECISION SUPPORT SYSTEM FOR WATER TRANSFER EVALUATION.
Nebraska Univ.-Lincoln. Dept. of Civil Engineer-

J. Stansbury, W. Woldt, I. Bogardi, and A. Bleed. Water Resources Research WRERAQ, Vol. 27, No. 4, p 443-451, April 1991. 6 fig, 3 tab, 21 ref.

Descriptors: \*Decision making, \*Management planning, \*Water demand, \*Water transfer, Agriculture, Case studies, Competing use, Environmental impact, Geographical information systems, Groundwater, Nebraska, Platte River, Regional analysis, Surface water, Water supply.

As the United States has changed from a young water economy to a mature one, there has been greater competition among water users (e.g., irrigators and municipalities) and more complex problems for water managers. A decision support system (DSS) was developed to help decision makers analyze the economic, social, and ecologi-cal ramifications of water transfers. Such a DSS is needed because the United States is evolving from needed because the United States is evolving from a development-oriented water economy to a more complex one that emphasizes conservation and reallocation (i.e., transfers). The DSS consists of three main modules: (1) a conjunctive surface-ground water model, (2) an impact analysis segment, which uses a geographic information system (GIS) that integrates model output with information from the study area to estimated economic, social, and ecological impacts, and (3) a multicriteria decision making algorithm that ranks the transfer schemes based on trade-offs of indicators which are assembled into a hierarchical structure. Ten different water transfer alternatives were extendible of the state of the which are assembled into a hierarchical structure. Ten different water transfer alternatives were examined in a case study to demonstrate the applica-tion of the proposed DSs. The study area consist-ed of Gosper, Phelps, and Kearney Counties in south-central Nebraska. The area is an agricultural region having significant groundwater reserves in the Ogalalla and similar aquifers. The major stream in the study area is the Platte River. It was found that the DSS can be a valuable aid for water managers because it: forces consideration of a wide range of impacts; allows complex technical inforrange or impacts; allows complex tecnmical intor-mation to be incorporated into the decision making process; users readily available personal comput-ers; employs GIS to facilitate analysis and interpre-tation of the results; uses accessible and easily understood weighting systems that establish confi-dence and facilitate sensitivity analysis; and, pro-vides final trade-off analysis in graphical form. ster-PTT)

RISK-BASED PERFORMANCE CRITERIA FOR REAL-TIME RESERVOIR OPERATION Manitoba Univ., Winnipeg. Dept. of Civil Engineering. nary bibliographic entry see Field 4A.

FIRST STEPS TOWARD INCREASING THE RELIABILITY OF HYDROPOWER AND WATER-MANAGEMENT FACILITIES. For primary bibliographic entry see Field 8A. W91-11291

FRAMEWORK FOR PLANNING, MONITOR-ING, AND EVALUATING WATERSHED CON-SERVATION PROJECTS. For primary bibliographic entry see Field 6B. W91-11570

EVOLUTION OF NEVADA'S WATER LAWS, AS RELATED TO THE DEVELOPMENT AND EVALUATION OF THE STATE'S WATER RESOURCES, FROM 1866 TO ABOUT 1960. Geological Survey, Carson City, NV. Water Resources Div. sources Div.
For primary bibliographic entry see Field 6E.
W91-11573

## 6B. Evaluation Process

PROPERTIES OF LINEAR PROGRAMMING MODELS FOR ACID RAIN ABATEMENT. Meteorologischer Dienst der DDR, Potsdam. For primary bibliographic entry see Field 5G.

### Field 6—WATER RESOURCES PLANNING

## Group 68—Evaluation Process

W91-10477

## DO WE HAVE A NATIONAL WATER POLICY.

Journal of Soil and Water Conservation JSWCA3, Vol. 46, No. 1, p 14-16, January/February 1991.

Descriptors: \*Public policy, \*Water policy, \*Water resources development, \*Water resources management, Federal government, Mississippi River, State governments, Tennessee Valley Authority, Water law, Water rights.

The national water policy is basically a reactive policy that has evolved in response to problems after they have arisen. Under the Constitution, the first reaction to water-related problems was to leave the responsibilities for their solution to the states and their inhabitants. The National Commission Waterways was established in 1910 to coordinate. sion Waterways was established in 1910 to coordinate policies of the water resources agencies with the USDA. A permanent Waterways Commission, the Newlands Commission, was authorized in 1917 to coordinate the work of the agencies, but it was never appointed. Instead, the Federal Power commission was formed in 1920. With the enactment of the Boulder Canyon Project Act in 1927 and the expansion of the Mississippi River and Tributaries Project in 1928, the pace of multiple-purpose water resources development substantially increased. It was not until the passage of the Tennessee Valley Authority Act in 1933 that a coordinated water resources policy received legislative recognition, but then only for the Tennessee Valiver Basin. Nuresources policy received legislative recognition, but then only for the Tennessee River Basin. Numerous other programs went on the books, but failed to be effective. In the meantime, water pollution control programs grew to dominate the water resources management field, with massive federal grant programs of up to 75% of the costs of publicly owned water treatment plants. Because of the history of the evolution of national water policy, water resources policy has always dominated land use policy in federal programs. Thus, many of the problems stem from the fact that land use policy has been handled by nonfederal governpolicy has been handled by nonfederal govern-ments and water policy has been primarily federal. For the future, water professionals, working with professionals in other resource management fields, are the ones who will have to develop policies that can be used to turn the system toward the long-term goal of conjunctive management of all natural resources. (Mertz-PTT) W91-10505

#### WATER FUTURES.

Agricultural Research Service, Fort Collins, CO. J. van Schilfgaarde. Journal of Soil and Water Conservation JSWCA3, Vol. 46, No. 1, p 17-19, January/February 1991. 2

Descriptors: \*Water policy, \*Water resources development, \*Water resources management, \*Wet-lands, Agriculture, California, Florida, Muck soils, Public policy, Water quality.

Water development has been crucial to the development of the U.S.. Draining of wetlands has opened up much land for agriculture. The period of American history when wetlands were mercilessly drained for farming and human inhabitation reflected a development ethos to conquer the land, to harness the water. This developmental ethos became a fundamental tenet of American culture. Development of water resources has served the nation well. The production of vegetables on the muck soils in southern Florida would be impossible without water development, as would farming in the Imperial Valley and the Central Valley in California. The country has suffered a tremendous loss of wetlands, however; some 90% of wetlands loss of wetnands, nowever; some 90% of wetnands are gone. Development has also led to loss of wild rivers, plant and animal species and degradation of water quality and other components of the ecosystem. Changes are beginning to occur. They are driven by the public and are slowly being endorsed by Congress and by state legislatures. There is now a move from an era dominated by development ethos into one dominated by an environmental ethic. A new, redrafted federal policy based on scarcity, not abundance is needed. The nuts and bolts of a new agenda would include a review of water policy that truly reflects the cost of service. It would also include a reevaluation of the subsidy system, so there is a consistency in federal policies between Agriculture and Interior. Industrial leaders seem to be able to see no further than their quarterly balance sheets. And when it comes to natural resources, there is a tendency to look no further than the next election. A longer view is necessary. (Mertz-PTT) W91-10506

## WATER CONTROL SYSTEMS AND THE TRA-DITIONAL FESTIVAL AT MIYAWAKI, ON THE SETO INLAND SEA.

National Inst. of Multimedia Education, Chiba (Japan).

For primary bibliographic entry see Field 3F. W91-10591

## WATER MANAGEMENT ISSUES FOR THE

Florida Univ., Gainesville. Coll. of Engineering. For primary bibliographic entry see Field 6D. W91-10807

#### CRITICAL AREA PROGRAM OF MARYLAND: IS IT CLEANING UP THE CHESAPEAKE BAY. Chesapeake Bay Critical Area Commission, Annapolis, MD.

S. J. Taylor. In: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 19-25, 10 ref.

Descriptors: \*Chesapeake Bay, \*Land use, \*Legal aspects, \*Maryland, \*Water pollution control, \*Water resources management, Decision making, Local governments, Pennsylvania, Regulations, State jurisdiction, Virginia

The Critical Area Protection Program for Mary-land's part of the Chesapeake Bay marked the first success for a State-mandated land use/growth management program. Premises, practice, and pre-scriptions played an important role in this success. The Critical Area Law improves coordination in two ways. First it sets up a vertical decision making structure for the development process, to ensure that landowners' actions are consistent with the stated goals of the law. Second, the Critical Area Law establishes a commission to monitor and regulate actions of local and state authorities. As a result of this program, which began in 1984, the Commonwealth of Virginia and Pennsylvania have Commonwealth of Virginia and reasons removed initiated land use/growth management programs of their own. In addition, Maryland is examining growth pressures and land use changes occurring in the rest of the state not subject to the Critical Area Program, with the intent of prescribing a growth management approach for its remaining lands. The effort's success will probably not be known for at least five more years, after the local jurisdictions have had the expe rience of these additional years of implementing their programs. Suc-cess will depend upon the willingness of local jurisdictions, State agencies, and landowners to be stewards of their resources and of their land, and to correct the imbalances in water, sediment, and nutrients flowing in the Bay. (See also W91-11003) W91-11006

## CHALLENGE OF IMPLEMENTING ECOSYSTEM MANAGEMENT PLANS IN THE GREAT LAKES BASIN.

Michigan Univ., Ann Arbor, School of Natural S. H. MacKenzie.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 69-77, 10 ref.

Descriptors: \*Environmental protection, \*Great Lakes, \*Interstate commissions, \*Water resources management, Ecosystems, Financial aspects, Politi-cal aspects, Public participation, Public policy, Water quality.

In order to maintain and enhance the integrity of the Great Lakes, an ecosystem approach to water resource planning and management should be adopted. The implementation of ecosystem management plans is critically important, yet inordi-nately difficult to achieve. There are six preconditions which are essential to the implementation of ecosystem approach: intergovernmental the ecosystem approach: intergovernmental co-ordination; interdisciplinary cooperation; political support; public participation; funding; and conflict resolution. Intergovernmental coordination and resolution. Intergovernmental coordination and interdisciplinary cooperation are the linchpins of ecosystem planning and management. By achieving these two preconditions, the administrative and programmatic capacity of governments to implement the ecosystem approach may be attained. The political arena struggles with the intricacies of balancing pluralist goals and democratic processes in a complex intergovernmental system. Disparate values and interests clash continually in an effort to dominate multic policy. The political arena is the values and interests clash continually in an effort to dominate public policy. The political arena is dy-namic and uncertain. Ecosystem planning and management is trying to find its niche within this institutional maze. The odds may well be stacked against widespread adoption of the ecosystem ap-proach, yet ultimately, its implementation may be essential to ecological survival. There are some essential to ecological survival. There are some indications that implementation of the ecosystem approach may be on the horizon in the Great Lakes region. The cause for optimism is found in the Remedial Action Plan (RAP) initiative under the auspices of the International Joint Commission (IJC). Since 1973, the IJC Water Quality Board has identified 42 'Areas of Concern' across the Great Lakes Basin where the quality of a Great Lake or its tributaries has been severely compromised, and extraordinary measures are needed for remediation. The vast majority of these 'hotspots' are located around harbors, connecting channels, and major municipalities. RAP plans are currently being designed to rectify these water quality prob-lems. While the jurisdictions responsible for devising the RAP have considerable latitude, they are expected to incorporate ecosystem concerns an tapetest of incorporate coststant concent and into their planning process. As such, they provide an exceptional means for studying the challenges of implementing the ecosystem approach. (See also W91-11003) (Lantz-PTT) W91-11011

## REVIEW OF INTERBASIN WATER TRANS-FERS WITH SPECIFIC ATTENTION TO BIOTA.

North Dakota State Univ., Fargo. Dept. of Civil

Engineering.
G. Padmanabhan, K. Jensen, and J. A. Leitch. IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 93-99, 23 ref.

Descriptors: \*Biological studies, \*Ecological effects, \*Environmental impact, \*Interbasin transfers, \*Water transfer, Aquatic life, Case studies, Ecosystems, Garrison Diversion Project, Literature review, Monitoring, North Dakot

Although economic aspects of large-scale interba-sin water transfers are of considerable importance, in recent years the biota transfer aspect of the problem has assumed greater importance. Many proposals for water transfers are opposed by the public on the grounds of biota transfer implications. An ecological assessment of large-scale water transfer is complex due to a lack of theory and information on biota transfer. Recognizing this and information on blota transfer. Recognizing this need, a multi-disciplinary research program on biota transfer studies sponsored by the Garrison Diversion Conservancy District and the State Water Commission (North Dakota) was instituted by the North Dakota Water Resources Research Institute. Several aspects of the problem are cur-rently being investigated under this program. One of the first tasks was to review the literature for evidence or lack thereof, of biota transfer in water transfer schemes which are already in place. Much transier schemes which are aiready in piace. Much ilterature is available on economic and technical feasibility studies; but the studies on biota transfer are relatively few. Most of the discussions appear to be philosophical at best, and comprehensive case studies are almost non-existent. This situation exists because: (1) the pre-monitoring and post-

## **Evaluation Process—Group 6B**

monitoring of biota transfer and impacts have to be over long periods of time to draw meaningful conclusions; (2) there are not enough baseline studconclusions, (2) there are not enough baseline studies; and (3) the science of evaluating biota transfer implications is in its infancy. The review clearly brought out the need for both diagnostic monitoring, which permits establishing trends or change in aquatic ecosystems, and prognostic monitoring, which will help predict the biological consequences of these changes or transformations of the quences of these changes or transformations of the ecosystems; the water transfer scheme should be conducted on a regular basis and under a prescribed program. Also, monitoring must continue under the same basis after the interbasin water transfer scheme is implemented to help evaluate the impact and, hence, to formulate remedial measures. (See also W91-11003) (Lantz-PTT) W91-11013

RESOLVING CONFLICTS ON THE DANUBE: THE GABCIKOVO-NAGYMAROS POWER DAM PROJECT.
Department of the Interior, Washington, DC.
I. L. Murphy.
IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 139-148, 5 fig, 12 ref

Descriptors: \*Danube River Basin, \*Gabcikovo-Nagymaros Power Dam Project, \*International commissions, \*International waters, \*Water re-sources management, Czechoslovakia, Financial aspects, Hungary, International agreements, Man-agement planning, Model studies, Political aspects.

Past and current decision processes affecting the rast and current decision processes artecting the use of Danube River Basin resources are exemplified by the recent controversy over the Gabcikovo(Bos)-Nagymaros Power Dam Project. For more than a decade it appeared that despite growing opposition from water users in riparian countries, and environmentalists in both east and countries, and environmentains in both east and west, that Czechoslovakia and Hungary would complete the construction of a large hydroelectric system on the Danube River. Hungarian government leaders, increasingly sensitive in this and other issue areas to an aroused electorate, decided other issue areas to an aroused electorate, decided in the late summer of 1989 to suspend its participation in the Bos-Nagymaros project pending environmental studies and constituent surveys. On October 30, 1989, the Hungarian parliament voted to withdraw permanently from the project. The basin is an important, threatened resource for all eight is an important, threatened resource for all eight riparian countries; discussion and negotiations, however, have not yet produced a conflict resolution process that might have prevented or could resolve the present dilemma. The planning, design and construction phases of the project were accomplished by bilateral agreements without a rigorous environmental impact assessment. The latest issue, which has resulted in acrimonious exchanges between the two Fastern European countries and issue, which has resulted in acrimonious exchanges between the two Eastern European countries, and the possibility of severe financial losses to both, has emphasized the need to put in place a decision process which ensures an equitable distribution of a vital, shared resource to all riparian countries. A policy model which has been tested on river basin conflicts elsewhere is used to analyze the current equation of the Danube and to make recommendasituation on the Danube and to make recommendastuation on the Danube and to make recommenda-tions for a permanent Danube-wide resolution process. These recommendations should include: (1) the establishment of a planning task group with membership from the appropriate water bureaus in each of the eight riparian countries and their for-eign ministries; (2) an agreement between the ripareign ministries; (2) an agreement between the riparian countries about a reporting deadline for a subgroup which would address information system needs; (3) discussion of the need for an integrated planning function and its proposed parameters—it should vote a budget and suggest activities for the next two years; and (4) the appointment of a subgroup of experts to assist with the resolution of the Bos-Nagymaros conflict. (See also W91-11003) (Lantz-PTT) W91-11018

FLUCTUATING WATER LEVELS IN THE GREAT LAKES-ST. LAWRENCE RIVER BASIN: AN EVALUATION FRAMEWORK FOR THE ANALYSIS OF POTENTIAL ACTIONS.

Corps of Engineers, Buffalo, NY. Buffalo District. J. W. Karsten, and C. N. Meeder. IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 229-239, 3 fig. 1 tab, 7 ref.

Descriptors: \*Fluctuations, \*Great Lakes, \*Great Lakes/St Lawrence River Basin, \*International Joint Commission, \*Water level, \*Water resources management, Data interpretation, Decision making, Economic aspects, Management planning, Political aspects, Social aspects.

The development and testing of an evaluation framework has been one of several significant activities undertaken within the International Joint Commission (IJC) Reference study on fluctuating water levels in the Great Lakes-St. Lawrence River basin. The evaluation process provides for an ongoing analytical capability for use by govern-ments and others. It consists of the following comments and others. It consists of the following com-ponents: (1) an inventory of existing and potential problems related to fluctuating water levels and their extremes; (2) an inventory of over 100 alter-native courses of action, classified into six types of measures; (3) an impacts matrix identifying possible impacts of measures on affected interest groups, including the natural environment; (4) selection and definition of six evaluative core criteria and 22 associated operational criteria; (5) assessment of measures through an evaluation instrument; and (6) measures through an evaluation must unless, and (y) compiling findings on alternative courses of action. The evaluation framework has demonstrated usefulness in organizing and structuring the process of conducting an evaluation and in docum lts. It does not remove the necessity of having to make technical judgements and value judgements in assessing the necessity of having to make technical judgements and value judgements in assessing uncertainties regarding economic, social, environmental, and political matters. It is a mechanism which requires the rendering of such judgements explicit. (See also W91-11003) (Author's abstract) W91-11026

FLUCTUATING WATER LEVELS: AN ISSUE MANAGEMENT APPROACH.

Guelph Univ. (Ontario). Dept. of Geography. B. Smit, and C. J. Stewart.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 299-307, 1 fig. 7 sef.

Descriptors: \*Decision making, \*Fluctuations, \*Great Lakes, \*Water level, \*Water resources management, Institutional constraints, Public policy, Resources management.

The Great Lakes provide a wide variety of services to interests in the basin. These services can be affected by fluctuating water levels. If expectations for gain from the services are not met, the affected parties may petition governments to act. These problems and their solutions are bounded by a complex and dynamic social, political and physical setting affecting the appropriateness of traditional benefit-cost approaches to evaluating potential actions. The conventional approach has been criticized for the narrow ranse of critieria examined, its cized for the narrow range of criteria examined, its reliance on judgements external to the affected parties, and a lack of public input. An alternative approach is offered in which no judgement is made approach is offered in which no judgement is made regarding the degree of adverse consequences suffered by an interest. Rather, the positions taken by the interests are examined for their underlying factual understanding and their relation to the responsibilities of governments. This focus on the impetus for petitioning facilitates the identification of government actions to effectively manage the issue. (See also W91-11003) (Author's abstract)

COSTS AND BENEFITS OF MOVING TO PEAK-LOAD PRICING FOR MUNICIPALLY-SUPPLIED WATER.

Brock Univ., St. Catharines (Ontario). Dept. of Economics.

For primary bibliographic entry see Field 6C. W91-11047

INDUSTRIAL WATER PRICING FOR ONTAR-IO: TOWARDS REALISTIC PRICING. Inland Waters Directorate, Ottawa (Ontario) For primary bibliographic entry see Field 6C W91-11048

WATER DIVERSION FROM THE GREAT LAKES AS A DYNAMIC GAME. Minnesota Univ., St. Paul. Dept. of Agricultural

Engineering. N. Becker, ar

N. Becker, and K. W. Easter.
IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 495-505, 6 tab, 19 ref. NOAA Grant No. NA86AA-0-SG112.

Descriptors: \*Decision making, \*Game theory, \*Great Lakes, \*International waters, \*Water resources management, Canada, Political aspects, Social aspects, United States, Water management.

The five Great Lakes can be classified common property or open access resource. This is a consequence of the lack of a well-defined system of property rights governing water use in the lakes. Decisions by interested parties are interconnected, since withdrawing water from one point may affect water levels in the entire system. This, in turn, can adversely affect hydropower production and commercial navigation. Contributing to the complexity of the problem are the eight U.S. states, two Canadian provinces and two federal governments. Game theory is implemented to describe this situation-several games are constructed to dethis situation-several games are constructed to de-scribe different market structures. Of particular interest is the number of players that participate in the game, as well as the expectations which they hold. Open-loop (where players commit them-selves to future actions) and closed-loop (where players do not commit themselves to future ac-tions) are compared for the ten players game (eight states and two provinces), two players game (U.S. usins) are compared for the ten players game (eight states and two provinces), two players game (U.S. versus Canada) and one player game (a social planner's solution). It is shown that trying to solve an open-loop game ignores part of the externalities involved, and thus can underestimate the social loss involved in these lakes. (See also W91-11003) (Author's abstract) (Author's abstract)

MICRO-TARGETING CROPLAND RETIRE-MENT FOR WATER QUALITY IMPROVE-MENT: MEASURING THE BENEFITS OF IN-CREASED INFORMATION

Minnesota Univ., St. Paul. Dept. of Agricultural and Applied Economics.

For primary bibliographic entry see Field 3F. W91-11052

AGRICHEMICALS AND GROUND WATER: ASSUMPTIONS ABOUT FARMER INFORMATION PROCESSES.

sin Univ.-Madison. Dept. of Soil Science. P. Nowak

P. Nowak. IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Man-agement. Freshwater Foundation, Navarre, Minne-sota. 1989. p 31-36, 3 ref.

Descriptors: \*Agricultural practices, \*Farm man-Descriptors: "Agricultural practices," artificial agement, "Groundwater quality, "Nonpoint pollution sources, Agricultural chemicals, Decision making, Farming, Groundwater pollution, Information transfer, Technology transfer, Water qual-

Most farmers face a situation of information over-load rather than information deprivation. They are consistently receiving different forms of informa-tion from manufacturers and suppliers of agricultion from manuacturers and suppurers of agricultural products and services, a complex stream of information on management and marketing strategies, government programs, financial or tax planning, and data on trends in world agricultural markets. The farmer also receives input from informations of the production of the production of the production of the production of the product of the production of the p nal sources deemed trustworthy and reliable. Critical information on the contamination of ground-water by agricultural chemicals is often lost in this maze of information overload. Consequently, farm-

## Field 6—WATER RESOURCES PLANNING

## **Group 6B—Evaluation Process**

ers often do not adopt remedial practices because they have not been properly informed on the basic economic and agronomic facts surrounding that practice. Although most of this information has been generated for the farmer, very little attention. been generated for the farmer, very little attention has been paid to information from farmers or about farmers. This information will be needed to reduce rarmers. Institution and the needed to reduce groundwater contamination in an effective fashion. Future programs and agendas should be designed to consider the farmer as the primary resource manager. (See also W91-11162) (Rubinstein-PTT)

COMMUNICATING WITH FARMERS: PRO-VIDING USEFUL AND RELIABLE SOURCES OF INFORMATION.

For primary bibliographic entry see Field 5G. W91-11164

EMERGING ISSUES AT THE INTERSECTION OF AGRICULTURAL AND ENVIRONMENTAL

For primary bibliographic entry see Field 5G. W91-11165

RED RIVER BASIN GRASS ROOTS POLICY

I. Yohe.

IN: Agrichemicals and Groundwater Protection:
Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. 259-264.

Descriptors: \*Decision making, \*Nonpoint pollution sources, \*Policy making, \*Project planning, \*Public policy, \*Red River Basin, Education, Evaluation, Geographic information systems, Land use, Organizations, Water quality control, Water

The Red River basin is a geographic area of 111,000 square miles and covers parts of Minneso-ta, North and South Dakota, Manitoba, and Saskatchewan. Residents of the basin feel the pressure to somehow affect the future directions of policy and decision making in order to deal with the land and water problems that exist in the basin. Involving basin residents, educating them on issues, and providing opportunities for cooperation are key components in implementing plans and solving these problems. In 1979, this grassroots involvement saw the development of the International Coalition for Land and Water Stewardship in the Red River Basin (TIC). The TIC has initiated many activities that in some manner relate to education or cooperation of basin residents to enhance their participation in the policy process. In addition, the TIC has sponsored several International Land and Water Summit Conferences where a consensus building process is used. The process enables participants to decide together an issue of priority and actions that can deal with the issues. This partnership role can be seen in the Comprehensive Local Water Planning project (CLWP) which brings together data (information) and the consensus process to enable local grassroots citizens and leaders to become enual partners with the cation or cooperation of basin residents to enhance zens and leaders to become equal partners with the state and others in planning and preparing for the future in land and water resource policy and deci-sion making. (See also W91-11162) (Korn-PTT)

MINNESOTA'S OLMSTED COUNTY: A COOP-ERATIVE HEALTH BASED PERSPECTIVE ON ZONING AND PLANNING.

Olmsted County Health Dept., Rochester, MN. Div. of Environmental Health. R. Peter.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 269-277.

Descriptors: \*Minnesota, \*Nonpoint pollution sources. \*Wastewater management, \*Water re-Descriptors: "Mannesota, "Nonpoint poliution sources, "Wastewater management, "Water resources management, Databases, Environmental policy, Evaluation, Interagency cooperation, Land use planning, Planning, Wells, Zoning.

The Division of Environmental Health of the Olmsted County Health Department administers suburban subdivision, onsite sewage treatment systems, and well construction programs. The association of the construction programs are supplied to the construction of the construction programs. ated inspections and permit procedures for each suburban and rural lot developed encourages orgasuburban and rural lot developed encourages organization of appropriate data and records on soil conditions, details on well and sewage treatment system construction and water quality, and assures regular contact with the public. In addition to the regulatory aspect of the County's environmental efforts, the Health Department and the Minnesota Geological Survey began a three year cost-shared study of the county's geology. This study produced county-wide water resources data bases and maps used for land use planning and health and zoning decisions. Currently, the Health Department is preparing a county water management plan zoning decisions. Currently, the Health Department is preparing a county water management plan using an intergovernmental approach. Technical experts from state, federal, and local agencies, as well as from private corporations, are providing the technical background data and analysis. (See also W91-11162) (Korn-PTT)

NORTHWEST KANSAS GROUNDWATER MANAGEMENT DISTRICT NO. 4, AN ABAN-DONED WELL PROGRAM.

For primary bibliographic entry see Field 5G. W91-11188

FARMER-INITIATED PROJECT TO PRO-MOTE SUSTAINABLE AGRICULTURE IN CO-OPERATION WITH THE EXTENSION SERV-

For primary bibliographic entry see Field 3F. W91-11203

WATER MANAGEMENT IN THE 21ST CEN-

For primary bibliographic entry see Field 4A. W91-11206

WASTE DISPOSAL FACILITIES AND COM-MUNITY RESPONSE: TRACING PATHWAYS FROM FACILITY IMPACTS TO COMMUNITY ATTITUDE

Alberta Univ., Edmonton. Dept. of Civil Engineering. For primary bibliographic entry see Field 5E. W91-11280

SOCIO-ECONOMIC IMPACT OF IMPROVED WELLS IN RURAL SIERRA LEONE, Njala Univ. Coll., Freetown (Sierra Leone). Dept. Naia Univ. Coli., Freetown (Sierra Leone). Dept. of Environmental Studies and Geography.

O. M. Bah, G. E. Hollis, and P. Richards.
Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 5, No. 1, p 36-42, February 1991. 1 fig, 10 tab, 6 ref.

Descriptors: \*Developing countries, \*Project planning, \*Sierra Leone, \*Water supply development, \*Wells, Benefits, Future planning, Rural areas, Social aspects.

The use and benefits of the improved wells con-structed with the participation of the local commu-nities in rural Sierra Leone was examined through nities in rural Sierra Leone was examined through data obtained from questionnaires in four sample villages. Interviews with well users and quantitative monitoring of water abstraction were also used to assess patterns of well use. Only 36% of the improved wells were operational in the dry season, and these made a modest contribution to water demand in the villages. Half the water consumption was on the remote farms where improved wells played a negligible role. Social and cultural difficulties with the wells caused reduced use of these improved water supply sources. Postuse of these improved water supply sources. Post-project evaluation by a multi-disciplinary team could provide invaluable inputs to the planning of future water supply development schemes in de-veloping countries. (Geiger-PTT) W91-11358

MANAGING WATER RESOURCES IN LATIN

Economic Commission for Latin America and the Caribbean, Santiago (Chile).

Natural Resources Journal NRJOAB, Vol. 30, No. 3, p 581-607, 1990, 5 fig, 2 tab.

Descriptors: \*Flow control, \*Political aspects, \*Regional development, \*Regulated flow, \*South America, \*Water resources management, Argentina, Chile, Colombia, Control systems, Evaluation, Irrigation programs, Latin America, Legal aspects, Peru, Water law, Water policy, Water supply development, Water use efficiency

Investment in water control projects has formed a major part of efforts to achieve economic development in Latin America over the last four decades. The result has been an increase in the regulation and control of rivers so that even the largest river systems are subject to considerable interference in their natural flow regimes. The expansion of con-trol works has raised the need to weigh the social trol works has raised the need to weigh the social question of managing complex water systems rather than operating individual control works directed towards satisfying the demands of specific uses. The nature of water management in Latin America was evaluated by examining four case studies of contemporary water management practices: (1) Irrigation in the Province of Mendoza, Argentina: (2) Water management and regional Argentina; (2) Water management and regional development in the Bogata River Valley, Columbia; (3) The Tinajones irrigation project, Lambayeque, Feru; and (4) Water management in the valley of the River Limari, Chile. The case studies show that despite some advances, the present state of water management is far from optimum. Many water management is lar from opinium. Many issues inherent to water system operation are being poorly handled and even ignored. Too commonly, the evidence from the case studies indicates that management actions have magnified rather than reduced the influence of unfavorable external con-ditions, neither have they responded to available opportunities. In general, the management institu-tions in the case studies do not demonstrate a dynamic style of management. Among all the technical, financial, and political problems encountered in the case studies, the need to achieve and maintain a high standard of management seems to be the most urgent. (Doyle-PTT) W91-11385

ASSESSING STREAM VALUES: PERSPECTIVES OF AQUATIC RESOURCE PROFESSIONALS.

Virginia Polytechnic Inst. and State Univ., Blacks-burg. Dept. of Fisheries and Wildlife Sciences. For primary bibliographic entry see Field 8I. W91-11425

DEVELOPMENT

WALESPIED DEVELOPMENT IN ASIA: STRATEGIES AND TECHNOLOGIES.
World Bank Technical Paper No. 127. World Bank Publications, Washington, DC. 1990. 227p.
Edited by John B. Doolette and William B. Ma-

Descriptors: \*Asia, \*Literature review, \*Management planning, \*Water resources management, \*Watershed management, Agricultural engineering, Crop production, Developing countries, Erosion, Land tenure, Land use, Research priorities,

A review of watershed development issues arose A review of watersited uperconducting sauce arose from the realization that a number of current and planned World Bank-supported projects in the Asia region deal with the linkages between upland productivity and environmental conditions and productivity and environmental conditions and are, in various ways, motivated by concern with downstream impacts such as flooding and sedimen-tation. High priority was attached to identifying discrete operational problems that could be better understood from review of existing data and analysis. In addition, the review was aimed at providing overall guidance to the Bank's dialogue with boroveran guidance of the Jank's unangement.

Working papers on six issues of direct operational concern were initiated, to be conducted by World Bank staff and consultants in the context of ongoing operations. These working papers, presented as

## Cost Allocation, Cost Sharing, Pricing/Repayment—Group 6C

chapters in the report, illustrate methodological approaches to project analysis, summarize the state of the art on solutions to technical problems and discuss institutional and social processes that bear heavily on the viability of watershed management projects. In addition to the research and operationwork that has gone into the working papers, a colloquium on watershed management was held at the World Bank in October 1988. Experts from research organizations and other agencies presented results of their work on a number of topics, including the impact of erosion on crop yields, sedimentation processes, and the impact of land tenure on development investments. (See W91-11564 thru W91-11570) (Fish-PTT)

ECONOMIC ANALYSIS OF OFF-FARM SOIL CONSERVATION STRUCTURES.
International Bank for Reconstruction and Development, Washington, DC. Environmental Policy Research Div.

For primary bibliographic entry see Field 4D. W91-11567

FRAMEWORK FOR PLANNING, MONITOR-ING, AND EVALUATING WATERSHED CON-SERVATION PROJECTS.

SERVATION PROBLETS.

G. S. Morgan, and R. C. Ng.

IN: Watershed Development in Asia: Strategies and Technologies. World Bank Technical Paper No. 127. World Bank Publications, Washington, DC. 1990. p 159-171, 1 ref.

Descriptors: \*Asia, \*Management planning, \*Project planning, \*Water resources management, \*Watershed management, Developing countries, Environmental policy, Evaluation, Land use, Monitoring, Multiobjective planning, Watersheds.

Watershed planning, monitoring, and evaluation (PME) tasks are frequently cited as among the most important components of successful projects. Nevertheless, the potential of PME activities will be achieved only if it is clearly understood who is to use the results and for what purposes and if the practical limitations of available methodologies and techniques are accepted. In general, there is agreement that monitoring and measurement of physical processes (crosion, deforestation) or physical delivery of project inputs is easier than measuring the less tangible, people-centered goals of watershed rehabilitation programs such as increasuring the less tangible, people-centered goals of watershed rehabilitation programs such as increasing beneficiary participation. In designing the PME components of watershed projects, the mutually reinforcing nature of these tasks must be clearly understood. The functional tasks that must be addressed by the staff responsible for implementing the PME components include: technical records the PME components include: technical records management, geography and cartography, village-level information management, watershed strategic planning, formulation of site-development plans and annual work program, monitoring progress; monitoring results, monitoring benefits, interiproject evaluations, evaluation of impact of physical treatments, and report generation (internal/ external). PME methodologies and procedures need to be flexible and well adapted to local circumstances. Due to the wide variation in objectives, scale and scope of investments in watershed projects, there can be no blueprint which is universally applicable or acceptable in all situations. In all situations, PME must be seen as an evolutionary process, building slowly on existing capabilities over relatively long time periods. This is particularly important when monitoring the effects of project investment on the productivity of natural systems such as forests, soils, or water. (See also W91-11563) (Fish-PTT)

## 6C. Cost Allocation, Cost Sharing, Pricing/Repayment

WATERSHED-BASED CONSERVATION PROGRAMS IS THE PUBLIC GETTING ITS MONEY'S WORTH.

Triton Environmental Consultants Ltd., Burnaby

(British Columbia).

M. Thompson IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 419-427, 2 fig,

Descriptors: \*Economic aspects, \*Water conserva-tion, \*Water resources management, \*Watersheds, Financing, Land use, Ontario, Recreation.

An assessment of the watershed-based conserva-An assessment of the watersned-oased conserva-tion programs requires a review of the techniques applied and the implementing agency. The conser-vation movement in Ontario was established in the early 1920s. Current annual expenditures of the 38 early 1920s. Current annual expenditures of the 38 Conservation Authorities on water and related land management, recreation, conservation education and administration totals 396 million. An example, the Saugeen Valley Conservation Authority, received up to 75% of its annual budget of \$2.2 million from provincial grants, the rest from program funds and local revenues. Through past conservation programs, Ontario has invested, over the past 40 years, close to \$1 billion in water control structures alone. Although these past watershed-based conservation programs provided great tangible and intangible benefits, the current review of Conservation Authority programs identified the one and mangione benefits, the current review of Conservation Authority programs identified the need of clear water and related land policies, ac-companied by increased funding. (See also W91-11003) (Author's abstract)

COSTS AND BENEFITS OF MOVING TO PEAK-LOAD PRICING FOR MUNICIPALLY-SUPPLIED WATER.

Brock Univ., St. Catharines (Ontario). Dept. of Economics.

In: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 453-461, 1

Descriptors: \*Cost-benefit analysis, \*Costs, \*Pricing, \*Water supply, British Columbia, Canada, Case studies, Economic aspects, Utilities, Vancouver. Water demand. Water resources management.

The pricing practices currently used by most North American water utilities are inefficient be-cause they do not reflect marginal costs. Further-more, the philosophy underlying the setting of the philosophy underlying the setting of is concerned more with cost recovery than prices is concerned more with cost recovery than signalling resource scarcity. An alternative ap-proach is to set prices to maximize the consumer's surplus net of supply costs. This leads to marginal cost pricing, and any factor affecting marginal costs may be incorporated into the pricing formucosts may be incorporated into the pricing formu-la. The efficiency gains arising from the move to marginal cost pricing may be outweighed, howev-er, by the costs of implementation if universal metering is required. A case study is examined; the costs of service and demand for water for the Vancouver Works are characterized statisti-cally. Costs are a function of input prices and quantities and the level of output. Demand is a function of price income and a vector of social quantities and the level of output. Demand is a function of price, income, and a vector of socio-conomic variables. A computer program simulates the move to marginal cost pricing (and its variant under cyclical demands, peak-load pricing) and computes costs and benefits. In several cases, the net benefits are positive. (See also W91-11003) (Author's abstract) W91-11047

INDUSTRIAL WATER PRICING FOR ONTAR-IO: TOWARDS REALISTIC PRICING.

Inland Waters Directorate, Ottawa (Ontario).
D. Tate, and R. Rivers.
IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 463-473, 4

Descriptors: \*Ontario, \*Pricing, \*Water resources management, \*Water supply, Canada, Costs, Economic aspects, Federal jurisdiction, Utilities, Water

Realistic water pricing is put forth in Canada's Federal Water Policy as one of five central strate-

gies for future water management. A system of two-part tariffs was suggested as being the most effective form of pricing, both for municipal water and for industrial water services. For industries and for industrial water services. For industries deriving their supplies from municipal systems, the fixed part of the tariff would be based on the share of fixed cost of each industry, while the part which varies with volume used would be based on the marginal cost of supplying water plus an extra strength sewer use charge. For self-supplied industries, a portion of the industrial water price would tries, a portion of the industrial water price would be designed to cover the costs of provincial and federal water management. A preliminary and quite rough example of the suggested system shows that, based on annual water management costs in Ontario of \$429 million, the water charge costs in Ornario of 3429 million, the water charge per cubic meter, prorated over the province's total industrial water use, would be \$0.18. Such a charge, if levied, could result in a 30% drop in industrial water intake and a 25% drop in consumption. (See also W91-11003) (Author's ab-W91-11048

WATER RATE STRUCTURE FOR DEMAND MANAGEMENT IN THE REGIONAL MUNICI-PALITY OF WATERLOO.

Triton Environmental Consultants Ltd., Burnaby (British Columbia).

(Orlins Columba). R. H. Tufgar, M. R. Follett, and B. A. Benninger. IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 475-484, 1 fig.

Descriptors: \*Water demand, \*Water rates, \*Water resources management, \*Water supply, Cost-benefit analysis, Costs, Economic aspects, Management planning, Model studies, Ontario, Waterloo.

The Regional Municipality of Waterloo, Ontario, reached a crisis period during the summer periods of 1988 and 1989 when demands for water, at times, reached or exceeded the capacity of high times, reached or exceeded the capacity of high growth with a fixed groundwater supply source. Plans are in place for additional source capacity, however, these facilities will not be in place until 1991. The Region has recognized the potential dangers of a relatively fixed water source comdangers of a realitively intended water source combined with an increasing demand, through growth, for a number of years. In the mid-1970s, a progressive water conservation program was developed to control water demands. In 1988 the Region initiated a water and sewage rate study to meet two objectives. First, the rate structure was to identify water supply costs, assign the costs to relevant categories and ensure that the revenue matched these costs. Second, the rate structure was to assist with demand management. The rate study met these objectives by identifying relevant cost categories, assessing the system demand structure by gories, assessing the system demand structure by consumer class and peaking characteristics, and developing a rate model that provides a structure to promote water demand management. The basis of the model is: that the cost/revenue balance reflects a user-pay approach; the accounting procedure follows American Water Works Association procedures; the base-extra capacity approach is used to reflect the peaking characteristics of the water system in the rates; that a component to capture the cost of long-term capital planning is included to help ensure smoother rates; and, that the rate structure reflects differences in consumer menueu to nep ensure smoother rates; and, that the rate structure reflects differences in consumer groups. Components from the areas available such as administration, regulation, education and operations management must be combined for an effective demand management program. (See also W91-11003) (Lantz-PTT) W91-11049

IMPLICATIONS OF FULL-COST RECOVERY WATER RATES ON IRRIGATED FARMS IN SASKATCHEWAN.

UMA Engineering Ltd., Lethbridge (Alberta). C. S. Fleming, and S. N. Kulshreshtha.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 525-534, 1 fig, 4 tab, 9 ref.

## Field 6—WATER RESOURCES PLANNING

## Group 6C—Cost Allocation, Cost Sharing, Pricing/Repayment

Descriptors: \*Cost-benefit analysis, \*Irrigation programs, \*Irrigation water, \*Pricing, \*Saskatchewan, Agriculture, Alfalfa, Crop yield, Potatoes.

It is the present water policy of the Saskatchewan government to subsidize irrigation water to farmers. Consistent with federal government guidelines, an analysis was made of the expected imports, if farmers were charged, so that the costs of water development (plus the operating and maintenance development (plus the operating and maintenance of water delivery system for irrigation) are covered. Impacts of such a price level were estimated on various size farms and crops grown under irrigation. Data on prices, costs, yields and water costs were obtained from secondary sources. Increased water charges adversely affected returns for most irrigation crops, with the exception of protectors. For allelie, sources the exception of protectors. potatoes. For alfalfa, returns were significantly reduced. Similarly, center pivot irrigation was affected the most, particularly that on small irrigated farms. (See also W91-11003) (Author's abstract) W91-11054

WILLINGNESS-TO-PAY FOR PROTECTION OF WATER SUPPLIES IN FOUR MASSACHU-SETTS' TOWNS.

New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Economics. J. Powell, and D. Allee. IN: International and Transboundary Water Re-

sources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 543-551, 1 fig, 6 tab, 7 ref. USGS Grant 14-08-001-G.

Descriptors: \*Drinking water, \*Massachusetts, \*Water costs, \*Water quality, Economic aspects, Social aspects, Trichloroethylene, Utilities, Water quality control.

Historically, water has been a cheap, abundant resource in the northeastern United States. This perception is being challenged by increasing demands from a growing population, and a decreasing supply resulting from contamination. This has forced a reassessment of the value of clean, safe water supplies. One way to estimate the worth of water is to measure the dollar amount people are prepared to spend on protecting the sources of supply. In the summer of 1989, a contingent valuation survey of four towns in Massachusetts was conducted to assess willingness-to-pay (WTP) for increased protection of their water supplies. All the towns in the study rely on groundwater for the public drinking water supply and two have experipublic drinking water supply and two have experi-enced contamination from trichloroethylene (TCE). The data indicate that there may be some significant differences in WTP for water supply protection based on local environmental condi-tions. The experience of a contamination incident appears to lead to higher valuations of a safe supply of water. At the present stage however, it is not clear whether this is the case. The issue is confounded as those who have experienced a con-tamination incident tend to view their water suptamination incident tend to view their water sup-plies as being less safe and thus may be prepared to pay more to reach the highest safety level. The analysis of WTP by safety level indicates a de-creasing WTP for more protection as perceived safety increases. (See also W91-11003) (Lantz-PTT) W91-11056

SOCIAL AND PRIVATE RETURNS FROM WETLAND PRESERVATION.

Guelph Univ. (Ontario). Dept. of Agricultural Ecconomics and Business.
For primary bibliographic entry see Field 5G.
W91-11057

EXISTING CONDITIONS FOR AGRICULTURAL UTILIZATION OF SEWAGE SLUDGE COMPOST IN JAPAN.
Japan Sewage Works Agency, Tokyo. Research and Technology Div.
For primary bibliographic entry see Field 5E.
W91-11152

FUNDING NEW YORK STATE'S INTEGRATED PEST MANAGEMENT PROGRAM.

IN: Agrichemica's and Groundwater Protection: Resources and Strategies for State and Local Man-agement. Freshwater Foundation, Navarre, Minnesota. 1989. p 207-212.

Descriptors: \*Agriculture, \*Cost allocation, \*Economic aspects, \*Funding, \*Insect control, \*New York, \*Nonpoint pollution sources, \*Pesticides, Administrative agencies, Agricultural practices, Crop production, Environmental effects, Public

Integrated Pest Management (IPM) is a system of agricultural pest management which makes use of every available technique to control pests to a level below that which causes economic injury, in a manner which is least harmful to human health and the environment. The implementation of IPM programs in New York State emphasizes demonstration, education and transfer of financial responsibility to the private sector. Transfer of programs sibility to the private sector. Transfer of programs to the private sector allows for a larger audience to be addressed yet presents several challenges in the development of a program. Involving the private sector in the management and decision making process from the outset is essential. Growers need to take the responsibility to help design IPM processes which meet their needs and are valuable. grams which meet their needs and are valuable to them, if they are going to eventually pay for them. There is a continuous need for dialogue and data There is a continuous need for dialogue and data exchange between the public and private institutions both before and after financial responsibility has been transferred. Although many challenges remain to be met, IPM programs in New York State have been and continue to be transferred to private funding. (See also W91-11162) (Korn-PTT) W91-11180

RURAL CLEAN WATER PROGRAM. For primary bibliographic entry see Field 5G. W91-11184

ECONOMIC ANALYSIS OF SOIL CONSERVA-TION TECHNOLOGIES.

International Bank for Reconstruction and Development, Washington, DC. Environmental Policy Research Div.
For primary bibliographic entry see Field 4D.
W91-11566

## 6D. Water Demand

WATER MANAGEMENT ISSUES FOR THE

Florida Univ., Gainesville. Coll. of Engineering. W. Viessman. Water Resources Bulletin WARBAQ, Vol. 26, No. 6, p 883-891, December 1990. 1 tab, 19 ref.

Descriptors: \*Evaluation, \*Future planning, \*Water demand, \*Water management, \*Water policy, \*Water quality, \*Water resources institutes, \*Water resources management, \*Water supply, Environmental protec-tion, Land use, Nonstructural alternatives, Regional analysis, Regional planning, Water allocation, Water issues, Water law, Water resources develop-

Water management includes applying structural and non-structural measures to problems related to water supply, water allocation, water quality, ex-treme events, and environmental protection. Needed are innovative approaches to problem solving, non-traditional coalitions for addressing regional issues, objective forums, foresight caparegional issues, objective forums, foresignt capa-bilities, and institutional reforms. The need for water management institutional reform is widely recognized, but the key to accomplishing it is hard to find. Support for change can be kindled and justified by analyzing and displaying the payoffs that could be achieved through alternative ways of solving problems and managing system. However, solving problems and managing systems. However, better coordination among planning and management agencies and greater consistency among plans, regulations, and actions remains a problem. The Administration and the Congress have taken the view that the states should assume a greater

portion of the national water management budget. However, some aspect of managing the nation's waters will require a sustained federal effort. The states should be provided some federal aid and guidance in the form of new financing options and professional cadres equipped to carry out expanded assignments. In addition, policies for land and water management should be consistent and coordinated. Finally, water policies of the future must take on a more global dimension. Few contemporary problems are local in nature. More emtemporary problems are local in nature. More emphasis must be placed on regional planning and management, and regional institutions to accommanagement, and regional institutions to accom-modate this must be devised. Unless the water policies of the future reflect a more holistic view, there will be little chance of staving off a water crisis of major proportions. (Korn-PTT) W91-10807

#### WATER USE REDUCTIONS FROM RETRO-FITTING INDOOR WATER FIXTURES

Brown and Caldwell, Pleasant Hill, CA. J. B. Whitcomb.

Water Resources Bulletin WARBAQ, Vol. 26, No. 6, p 921-926, December 1990. 1 fig, 3 tab, 4 ref.

Descriptors: \*Domestic water, \*Model studies, \*Plumbing, \*Water conservation, \*Water use, \*Water use, \*Statistical analysis, Uncertainty, Water demand, Water fixture retrofitting, Water supply, Water use modeling.

Water supply planners are using estimates of po-tential water savings from installation of water conserving devices to design retrofit programs throughout the country. However, a fair amount of uncertainty exists in these water saving esti-mates. The primary reason for the uncertainty is that water savings change as household water use characteristics, both technological and demographic in nature, change. A water use model was devel-oped to estimate water savings from the installa-tion of low-flow showerheads and toilet displacement devices in residential housing. The model measured household water use in per capita terms measured nousenoid water use in per capita terms with adjustments for age of occupants, household income, and type of water fixtures. The results of the study revealed that water use reductions from retrofitting indoor water fixtures depend on both technological and demographic characteristics. The occupant's age and income had a pronounced effect on water savings. One consequence of the effect on water savings. One consequence of the study is that it informs water resource planners to be wary of extending a single water savings esti-mate calculated in one region to another. Regional differences in these types of characteristics can significantly affect water savings. In addition, the estimates of water savings can also provide useful information to other water agencies interested in the effectiveness of these types of retrofit devices. (Korn-PTT) W91-10811

## RESIDENTIAL WATER CONSERVATION: CASA DEL AGUA.

Arizona Univ., Tucson. Office of Arid Lands Stud-For primary bibliographic entry see Field 3D. W91-10814

## TRANSFERABILITY OF WATER ENTITLE-MENTS IN AUSTRALIA.

University of New England, Armidale (Australia). Centre for Water Policy Research. For primary bibliographic entry see Field 6E. W91-10850

COOPERATIVE DATA ON REGIONAL WATER USE: THE GREAT LAKES REGIONAL WATER USE DATA REPOSITORY. COOPERATIVE

Great Lakes Basin Commission, Ann Arbor, MI. T. R. Crane, and C. A. Ratza. IN: International and Transboundary Water Re-

sources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 57-67, 4 fig, 3

## Water Law and Institutions—Group 6E

Descriptors: \*Data collections, \*Databases, \*Great Lakes, \*Water use, Data interpretation, Data storage and retrieval, Groundwater resources, International agreements, Interstate compacts, Surface water, Water demand, Water resources management, Water supply.

In 1987, the Great Lakes Regional Water Use Data Base Repository was established at the Great Lakes Commission by an international Great Lakes Water Resources Management Committee. During its second year of operation, the repository has worked closely with water management experts from throughout the region to refine reporting requirements and measurement techniques to better represent annual water withdrawals and consumption in the Great Lakes Basin. The database catalogs water withdrawal and consumption in nine active categories of use for ten jurisdictions and six subbasins by three types of withdrawal (groundwater, Great Lakes surface water and tributary streams or other surface water). Reports of ways and are becoming more refined and useful in regional planning and estimation as jurisdictions move toward full compliance with data input requirements. The future utility of the database will be enhanced as the individual jurisdictions continue their efforts to improve estimation techniques, measure rather than estimate water withdrawals, and establish standard and timely data collection and reporting programs. Continued state and provincial interest and involvement in refining and expanding the database is desirable to ensure that the database and repository continue to support jurisdictional needs and other ongoing Charter initiatives in the future. (See also W91-11003) (Lantz-PTT)

WILL FREE TRADE DRINK CANADA DRY. Department of the Environment, Ottawa (Ontario). Inland Waters Directorate.

In: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 383-392, 1 fig, 2 tab, 15 ref.

Descriptors: \*Canada, \*Free trade, \*International agreements, \*Legislation, \*Water resources management, \*Water supply, Hydroelectric power, Regulations, Social aspects, Water resources.

During the great national debate in 1988 over free trade with the United States, some critics in Canada charged that water resources would be subject to the terms of the proposed trade agreement. The response of the Government of Canada was first to deny the charge, then to accelerate legislation banning large-scale water export. Analysis of the opposing positions and of related events is inconclusive at this time. For the next few years, however, there appears to be too much opposition in Canada and too little interest in the United States for continental water marketing to be taken seriously. But Canada's water resources may be implicated by the Free Trade Agreement in another way than diversion of lakes or rivers across the international boundary. Rather than commit water for export, some provinces are exploring the economic rewards of building water projects for the generation of electricity which would be committed entirely for export. This would have the effect of tying up northern water systems for long periods in advance of domestic needs and in spite of abundant evidence of environmental and social disruptions caused by existing hydroelectric development. (See also W91-11003) (Author's abstract) W91-11041

WATER RATE STRUCTURE FOR DEMAND MANAGEMENT IN THE REGIONAL MUNICIPALITY OF WATERLOO.

Triton Environmental Consultants Ltd., Burnaby (British Columbia). For primary bibliographic entry see Field 6C. W91-11049

WATER MARKET IN THE SOUTHERN FRONT RANGE OF COLORADO.

Colorado Coll., Colorado Springs. Dept. of Economics and Business.

M. G. Smith.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 535-542, 1 fig, 13 ref.

Descriptors: \*Colorado, \*Water demand, \*Water resources management, \*Water rights, \*Water transfer, Agriculture, Competing use, Domestic water, Legal aspects, Water supply, Water use.

Water markets have existed in Colorado for some time; farmers within the same mutual ditch company have rented and traded water between themselves for over 80 yrs. What is new in the last 20 yrs is the entry of cities into the water market to purchase agricultural water for transfer into municipal, commercial and industrial uses. The result of these sales is the wholesale reallocation of water away from agriculture to the cities and from one region to another. Who the buyers are for any particular water right is largely determined by a city's ability to capture, store and convey the water to its customers. While Denver is the largest city along the Front Range of Colorado, with the most extensive conveyance and storage system, it has been one of the least active players in the water market over the last 20 yrs. The two most active players in the water market have been the cities of Aurora and Thornton. Aurora takes water from the Arkansas River through the pipeline that is jointly owned with Colorado Springs, while Thornton has gone north to purchase water from the Cache la Poudre River and west for rights on Clear Creek. Golden, Arvada and Westminster are also purchasing water rights on Clear Creek. Colorado Springs can capture water from Fountain Creek and directly from the Arkansas. The city has purchased water rights from both Twin Lakes and the Colorado Canal Company on the Arkansas. Water rights have a number of attributes that determine their value in the market. These are: priority date, adjudication date, source, location and type of use. Two principle types of sales make up the major water transfers from farmers to the cities within the region: water right transfers and shares in mutual ditch companies. A water rights transfer is the sale of a water right from one party to another. Shares in mutual ditch companies were originally founded to manage the irrigation ditches withdraw from farming or ranching they are free to sell their shares. Anyone is free to buy these shares as long as they can demonstr

DECISION SUPPORT SYSTEM FOR WATER

TRANSFER EVALUATION.
Nebraska Univ.-Lincoln. Dept. of Civil Engineering.

For primary bibliographic entry see Field 6A. W91-11226

SELECTION OF THE OPERATING REGIME OF THE ONEGA-SVIR' WATER SYSTEM UNDER CONDITIONS OF INCREASING WATER CONSUMPTION.

WATER CONSUMPTION.
V. A. Kotel'nikov, and G. S. Arsen'ev.
Hydrotechnical Construction HYCOAR, Vol. 24,
No. 6, p. 375-383, December 1991. 3 fig, 6 tab, 4 ref.
Translated from Gidrotekhnicheskoe Stroitel'stvo,
No. 6, pp. 17-22, June, 1990.

Descriptors: \*Hydrologic budget, \*Lake Onega, \*Reservoir operation, \*Soviet Union, \*Svir River, \*Water demand, Hydroelectric plants, Seasonal distribution, Systems analysis, Water consumption, Water supply.

Increased economic activity has created problems in management of the Lake Onega-Svir River water resources complex (Soviet Union). Increased water consumption (particularly nonreturnable water consumption) and intrabasin water redistribution are occurring. In the future, interregional redistribution of water may be needed to solve the

water supply problem. Lake Onega and a 97-km stretch of the Svir' River, including the Ivinskii floodplain, constitutes a single reservoir of the Upper Svir' hydroelectric station. A study was undertaken to determine the water balance of the reservoir of the Upper Svir' hydroelectric station using data covering the 31-yr period of operation from 1953/54 to 1983/84. Two activities are of particular importance on this system: water transport and hydroelectric power generation. The outcome was examined of two variants of runoff from Lake Onega: 3.5 and 7.5 cu km/yr. Discharges were determined as probability curves for these two scenarios. The annual generation of electricity by hydrostations of the Svir' cascade could decrease by 18% with withdrawals of 3.5 cu km/yr and by as much as 36% with withdrawals of 3.5 cu km/yr and by as much end of the installed capacity of the hydrostations of the Svir' River is guaranteed only in the winter. In the summer the interests of the hydropower industry are slighted to provide for water transport needs. (Rochester-PTT)

METHOD OF COMPILING WATER-MANAGEMENT BALANCES.

For primary bibliographic entry see Field 2A. W91-11293

STABILITY OF HYDROPOWER CONSTRUC-TION PROGRAMS.

For primary bibliographic entry see Field 8C. W91-11294

RESALE OF THE COLUMBIA RIVER TREATY DOWNSTREAM POWER BENEFITS: ONE ROAD FROM HERE TO THERE.

Washington State Energy Office, Olympia. For primary bibliographic entry see Field 6E. W91-11386

STUDENT WATER USE.

W. M. McLellon. Journal of the American Water Works Association JAWWA5, Vol. 83, No. 4, p 132-133, April 1991. 1 fig. 1 tab. 6 ref.

Descriptors: \*Water demand, \*Water use, Domestic water, Laundering, Statistical analysis, Surveys, Wash water.

Students in a senior-level water supply course at the University of Central Florida were required in order to account for all personal water use over a 24-hour day) to compare student demands with values reported in the literature. The accounting was done by successive classes over 8 years, totaling 252 students. The average use was 93.6 gal/capita/dgpcd), within the figures found in the literature. The observed range was 74.2 gpcd to 143.3 gpcd. The latter value was apparently an anomaly, because it was far outside the other seven averages, which ranged from 74.2 to 96.2 gpcd. Overall average percentages for use of waste disposal for the eight classes were somewhat different from published values. Food service and laundry use percentages were reasonably close to published values. On a probability plot, the anomaly of the 143.3 gpcd point stands out immediately, the remaining seven values producing a straight line. From the plot, the mean was 89 gpcd, with a standard deviation of 13 gpcd. For a one-in-100 probability, the values were 59 gpcd and 119 gpcd. (Doria-PTT)

### 6E. Water Law and Institutions

DO WE HAVE A NATIONAL WATER POLICY. For primary bibliographic entry see Field 6B. W91-10505

CITIZEN'S MOVEMENTS TO PROTECT THE ENVIRONMENT OF RIVERS FLOWING INTO THE SETO INLAND SEA: AN EXAMPLE OF A

## Field 6—WATER RESOURCES PLANNING

## Group 6E-Water Law and Institutions

CITIZEN'S MOVEMENT ALONG THE TOGA

RIVER.
The Group to Protect the Toga River, 4-12, Shi-kanoshita-dori, 1 chome, Nada-ku, Kobe, 658

For primary bibliographic entry see Field 5G. W91-10587

NONGOVERNMENTAL EDUCATIONAL ACTIVITIES FOR ENVIRONMENTAL PROTEC-

Hiroshima Community Health Service Association (Japan). Div. of Education.

For primary bibliographic entry see Field 5G. W91-10588

PROVIDING ACCESS FOR THE PUBLIC TO THE SHORELINE OF SAN FRANCISCO BAY. San Francisco Bay Conservation and Development nission, CA. N. Wakeman.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 637-638, 1991.

Descriptors: \*California, \*Coastal areas, \*Public access, \*San Francisco Bay, \*Shores, Coastal zone management, Public participation, Regulations.

The San Francisco Bay Conservation and Development Commission has responded to the public desire for access to the shoreline and a view of the water through the regulatory program for the San Francisco Bay area. The Commission, created as the result of a citizen initiative in the 1960's, uses the Design Beautyn Pearly and and a statement of the Pearly Review Pearly and and a statement of the Pearly Review Pearly and the Pearly Review Pearl the Design Review Board and design guidelines to assure that public access areas are well designed assure that public access areas are well designed and integrated into project development. The Commission set up a process to allow professional designers to review public access plans prior to their being reviewed by the Commission. The success of the Commission's record is due to its law, experience and designed their project of the commission's record is due to its law, policies, and decision-making process. When the Commission was established in 1969, only 10 miles of the 700 miles of San Francisco Bay shoreline was available for public use. Now over 100 miles of shoreline are available. (Brunone-PTT) W91-10589

REPORT OF THE RIVER MASTER OF THE DELAWARE RIVER, FOR THE PERIOD DE-CEMBER 1, 1988-NOVEMBER 30, 1989. Geological Survey, Reston, VA. For primary bibliographic entry see Field 4A. W91-10765

NEGOTIATION TECHNIQUES TO RESOLVE WESTERN WATER DISPUTES.

National Ecology Research Center, Fort Collins,

B. L. Lamb, and J. G. Taylor. Water Resources Bulletin WARBAQ, Vol. 26, No. 6, p 967-975, December 1990. 1 fig, 33 ref.

Descriptors: \*Legal aspects, \*Negotiations, \*Resource allocation, \*Water allocation, \*Water law, \*Water rights, Bargaining, Conflict resolution, Instream flow, Problem solving, Public participation, Water resource management.

Every water resource negotiation has its own special characteristics. The first thing to be avoided is the temptation to apply a mechanistic process to dynamic, value-oriented problem solving. Using a simple model of negotiation misses many opportunities for improved outcomes. More fruitful negotiations are possible when one recognizes the rich complexity of water rights disputes expressed in competitive, cooperative, and integrative bargain-ing. Even though the competitive strategy is the most common starting place, it can be shown that, under most circumstances, disputes can be much more productively resolved if approaches evolve more productively resolved if approaches evolve toward cooperative or innovative strategies. One key to productivity is recognizing the strategy that dominates bargaining. The history of a dispute, as well as the record of opponents' behavior, are both excellent guides for identifying strategy. Success is achieved when the parties move beyond mere mechanical attempts to use tactics and progress

toward mutual problem-solving. The ability to do
this is conditioned by the number of parties involved, the mixture and disparity of values held,
attentiveness of various publics, the presence of a
strong third party, and the participants' abilities to
evaluate and use technical information. Understanding all these factors must be covaled with standing all these factors must be coupled with skill in identifying the real needs of the parties involved. (Korn-PTT) W91-10817

TRANSFERABILITY OF WATER ENTITLE-MENTS IN AUSTRALIA. University of New England, Armidale (Australia). Centre for Water Policy Research. J. J. Pigram, and W. F. Musgrave. Regulated Rivers Research & Management RRMEP, Vol. 5, No. 5, p 391-399, November/ December 1990. 2 tab, 25 ref.

Descriptors: \*Australia, \*Local governments, \*Water demand, \*Water entitlements, \*Water management, \*Water rights, Industrial water, Irrigation water, Legal aspects, Urban areas, Water esources, Water use.

Until recently, entitlements to water in Australia have been tied to a specific area of land. Several State water management agencies have now adopted more flexible arrangements for the transfer of water rights between users on regulated streams.
The case of freer transfers is linked to the per-ceived need for greater efficiency in water use.
Transferability also has potential in facilitating the movement of water between different sectors of the water industry and in achieving more rational and environmentally acceptable use of resources. Justification for breaking the nexus between water rights and land needs to be assessed against a number of physical, social, economic, and environmental issues some of which have only become apparent with accelerated resource development, and expansion and concentration of Australia's urban-industrial base. These trends are reflected in urban-industrial base. These trends are reflected in competing claims on water resources to supply the increasing demand from city-based populations; to maintain the viability of industrial systems; to sustain more intensive high technology forms of irrigation agriculture; and to satisfy the water needs of often remote mining and tourist developments. No longer can such claims easily be met by harnessing further water resources. Transfers of water rights, on a much larger scale, within and between wateron a much larger scale, within and between waterusing regions and sectors, and across State borders, are likely to be an important element in Australia's water industry in coming decades. (Author's abstract) W91-10850

INTERNATIONAL AND TRANSBOUNDARY WATER RESOURCES ISSUES.

Proceedings of the Symposium held April 1-4, 1990, Toronto, Ontario. American Water Resources Association, Bethesda, Maryland, 1990. 652p. Edited by John E. FitzGibbon.

Descriptors: \*International agreements, \*Interna-tional waters, \*Water resources management, Great Lakes, Great Lakes/St Lawrence River Basin, Interstate commissions, Legal aspects, Re-sources management, Water resources develop-ment Water supply. ment, Water supply.

The symposium provided an opportunity for the American Water Resources Association and the Canadian Water Resources Association to bring together the water resource issues and concerns together the water resource issues and concerns that are shared by the peoples of North America. These interests are shared both in terms of management of the drainage systems that span the common borders, and in the sense of shared issues and problems within the two nations (Canada and the United States). The operations and successes and failures of regional water resource organizations formed two special sections focusing on the organizations that deal with water resource management problems. It provides a prospective on the various approaches to water resource management and highlights the outcomes of some of these ap-proaches. The second theme of the symposium is that of transboundary water. Transboundary

waters represent an important area of concern not only in terms of the Canadian-United States boundary, but for any water body which is within more than one jurisdiction. The management of these than one jurisdiction. The management of these resources requires a commitment to the common good on the part of all jurisdictions and thus a coordination of approaches, agencies and programs. The third theme deals with the Great Lakes and St. Lawrence--the major shared drainage system between Canada and the United States. The size of this system and its importance to the large concentrations of population that depend on them makes the management of the Great Lakes a key on-going issue. The papers in these proceedings provide a comprehensive view of the current status of management of the Great Lakes. The fourth theme is one that is shared by all water managers, that is the problem of determining the fourth theme is one that is shared by all water managers, that is the problem of determining the value of water resources. The problem of pricing and valuation of this common property is seen as a key to effective management of water resource use. The challenge outlined in the papers is the search for an appropriate means of determining the value of water and how to charge for it. The fifth theme is that of the history of Canada and the United States water resources policy and manage-United States water resources policy and management. The final themes relate to several major problems which are of critical importance to the management of water. These include the impact of climatic change on water resources, the management of groundwater and water quality management. (See W91-11004 thru W91-11065) (Lantz-W91-11003

GREAT LAKES CHARTER: POTENTIAL AND REALITY

New York State Public Services Commission, Albany. H. G. Williams.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 1-9, 6 ref.

Descriptors: \*Great Lakes, \*Great Lakes Charter, \*International agreements, \*Water resources management, Canada, Databases, Decision making, International commissions, Public policy, United States Water use

The Great Lakes Charter, adopted by the Great Lakes governors and premiers in 1985, commits the governors and premiers to manage the water resources of the Great Lakes Basin cooperatively and in accordance with a watershed management strategy that reflects the unity of the Great Lakes system. The Charter includes an action program to provide better information for future water man-agement decisions. The key feature of this action item is a committee to oversee the development of a common database on Great Lakes water use and a basin water management program to provide a policy and decision making framework for the states and provinces. The Charter encourages sup-port for research regarding flows and lake levels required to protect Great Lakes water resources. The process established by the Charter has resulted in measurable progress in the development of a in measurable progress in the development of a strategy to manage diversions and consumptive uses of Great Lakes water resources, but essential actions remain to be taken by the states and prov-inces before the Charter's potential is fully real-ized. (See also W91-11003) (Lantz-PTT) W91-11004

WHAT MAKES REGIONAL ORGANIZATIONS SUCCEED OR FAIL.

Harvard Energy and Environmental Policy Center, Cambridge, MA. For primary bibliographic entry see Field 6A. W91-11005

CHANGING DYNAMICS OF INTEREST REPRESENTATION IN WATER RESOURCES MANAGEMENT,

University of Western Ontario, London. Dept. of Geography. L. G. Smith.

IN: International and Transboundary Water Re-

## Water Law and Institutions-Group 6E

sources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 27-34, 7 ref.

Descriptors: \*Decision making, \*Model studies, \*Water law, \*Water resources management, Management planning, Standards.

Theoretical development of interest representation has been stalled by an inability to clarify the role of such key concepts as power and justice, especially for resource issues affecting multiple publics. The individual context of each situation minimizes the individual context of each situation minimizes the utility of normative models and leaves the issue of a general theory up in the air. Dispute resolution conforms to this mould. Circumstance, history and local conditions restrict the viability of manuals and deterministic models seeking to outline various means for the resolution of conflict. In a practical sense, a well developed, detailed schematic model for negotiated approach to water management is both unwarranted and unverifiable. The Stakeholder Model, which combines philosophy, goals, and strategic planning, is intended as a conceptual guideline for the implementation of a negotiated approach in the provision of interest representation in decision making. The model not only lacks any pretense of theory but, because implementation is site specific, it also lacks specifics regarding procedure. (See also W91-11003) (Lantz-PTT)

LEGAL REGIMES FOR INTERSTATE WATER ALLOCATION IN THE WESTERN UNITED STATES: SOME SUCCESSES AND FAILURES. Mexico Univ., Albuquerque. School of Law C. T. DuMars.

In: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 35-46.

Descriptors: \*Colorado River Basin, \*Interstate compacts, \*Legal aspects, \*Water allocation, \*Water law, \*Water securces management, \*Water supply, Competing use, Decision making, Pecos River Compact, Upper Colorado River

The Colorado River Compact, the Upper Colorado River Compact, and the Pecos River Compact are explored. The Colorado River Compact provides a classic example of intentional deferral of vides a classic example of intentional deferral of difficult legal problems. The Upper Colorado River Compact is an example of a compact which has worked well because of a fundamental need of has worked well because of a fundamental need of the States to cooperate. The Pecos River Compact is an example of a compact which did not leave the problems to future generations, but created prob-lems due to both bad engineering and an unwork-able-decision making structure. There are certain provisions which are destined to provide litigation in the future. For example, where a compact does not make provision for some majority vote, as in the case of the Pecos River Compact. Or, as in the case of the Colorado Compact, where the delivery. case of the Colorado Compact, where the delivery obligation is fixed by a flat quantity of water and the sources of that water are not clearly defined. Likewise, as in the case of the Pecos River Compact, where depletion actions of the upstream user are prohibited with the goal of making more water are prohibited with the goal of making more water available to the downstream user problems are inevitable if the compact is unclear. Finally, a settlement that does not provide all of the negotiatsettlement that does not provide all of the negotiat-ing states with the financial capacity to utilize their share of the water spells trouble. The simple reality is that if one entity benefits by using its water and by ensuring that its counterpart does not use its water, conflict is inevitable. The interstate compact is an excellent political tool. These compacts have drawn the overall contours of the allocation of water in many rivers in the Western United States, but interstate management problems in many cases have not been solved—they are just beginning. (See also W91-11003) (Lantz-PTT)

INTERSTATE COOPERATION IN DEALING WITH GROWTH RELATED WATER QUALITY IMPACTS ON THE CHESAPEAKE BAY. Rogers, Golden and Halpern, Inc., Philadelphia, B. F. Golden.

IN: International and Transboundary Water Resources Issues. American Water Resources Asso ciation, Bethesda, Maryland, 1990. p 49-56.

Descriptors: \*Chesapeake Bay, \*Environmental effects, \*Environmental protection, \*Interstate compacts, \*Urbanization, Conservation, District of Columbia, Education, Financial aspects, Interstate commissions, Land use, Maryland, Pennsylvania, Population growth, Regulations, Taxes, Virginia.

Population growth, Regulations, Taxes, Virginia.

Chesapeake Bay is influenced largely by three States-Pennsylvania, Maryland, and Virginia-albeit in different ways. These three jurisdictions, plus the District of Columbia, the US EPA, and the Chesapeake Bay Commission constitute the Chesapeake Executive Council. In an historic and unique agreement, these jurisdictions have agreed to reduce the impacts each creates on the Bay and its tributaries. A key component of this effort will be a rationalization of land development practices throughout the watershed. A 12-member panel was appointed to examine the issues of population growth and development in the Chesapeake watershed to the year 2020. The panel established seven visions' of how the projected 2.6 million new residents should be accommodated. These are: (1) development is concentrated in suitable areas; (2) sensitive areas are protected; (3) growth is directed e areas are protected; (3) growth is dire to existing population centers in rural areas rce areas are protected; (4) stewardship of the nd the land is a universal ethic; (5) conservabay and the and is a university conserva-tion of resources, including a reduction in resource consumption, is forced practiced throughout the region; and (6) funding mechanisms are in place to achieve all other visions. Each vision has a series of implementing "actions", including: establish fedof implementing actions, including: establish re-eral, state and local buffer zone programs that require adequate deep-rooted vegetated buffers be left undeveloped around sensitive resources and along all watercourses and water bodies; state and along all water-courses and water bodies; state and local governments must protect water supply watersheds from development; state agencies should establish written environmental stewardship policies to guide their actions and should review their programs to ensure conformance within these policies; states should develop a required school curriculum unit focused on environmental and growth cies; states should develop a required school curriculum unit focused on environmental and growth issues; states should make best environmental management practices mandatory for development, agriculture, and forestry; develop revenue sharing or pooling arrangements among municipalities or counties affected by growth; and, states should encourage development of local taxing districts to allow local governments to recover the operating costs of public facilities unique to that district. The quantification of impacts from these densities led he panel to conclude that the States must take a pivotal role in land use management, or all the technical approaches to improving Bay water quality would be overwhelmed simply by growth. (See also W91-11003) (Lantz-PTT)

CHALLENGE OF IMPLEMENTING ECOSYSTEM MANAGEMENT PLANS IN THE GREAT LAKES BASIN.
Michigan Univ., Ann Arbor. School of Natural

For primary bibliographic entry see Field 6B. W91-11011

POLITICAL ECONOMIC MODEL OF INTER-

NATIONAL POLLUTION.
Minnesota Univ., St. Paul. Dept. of Agricultural and Applied Economics.
For primary bibliographic entry see Field 5B.
W91-11016

REMOVAL OF BIOTA FROM INTER-BASIN TRANSFER WATER.
North Dakota Univ., Grand Forks. Dept. of Civil

For primary bibliographic entry see Field 5F. W91-11017

RESOLVING CONFLICTS ON THE DANUBE: THE GABCIKOVO-NAGYMAROS POWER

Department of the Interior, Washington, DC. For primary bibliographic entry see Field 6B. W91-11018

APPLYING SUSTAINABLE DEVELOPMENT TO THE GREAT LAKES-EXPERIENCE AND OPPORTUNITIES UNDER THE BOUNDARY WATERS TREATY.

International Joint Commission-United States and Canada, Ottawa (Ontario).

G. Thornburn.

G. Inornourn.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 149-158, 6 ref.

Descriptors: \*Boundary Waters Treaty, \*Great Lakes, \*Institutional constraints, \*International agreements, \*Sustainable development, \*Water resources development, Hydroelectric powerplants, Nonpoint source pollution.

A review of the practice and experience of the International Joint Commission under the Boundary Waters Treaty provides many examples as to how the concepts of sustainable development can be and have in fact been applied. The reasons for an early interest in these concepts include the very process by which the Commission ensured that all affected interests were taken into account in deciaffected interests were taken into account in decision-making, an approach that inevitably lead to a tracing of a wide range of impacts both directly and indirectly through environmental linkages. Examples are drawn from the 75-yr history of the Commission within the Great Lakes region. Specific recent examples include the Commission's approach to the redevelopment of hydro-power facilities at Sault Ste. Marie, the assessment of diversions and consumptive uses of Great Lakes water nonpoint pollution, and the Remedial Action Plans (RAPs) under the Great Lakes Water Quality Agreement. Opportunities for applying sustainable development principles can be found, especially in the RAPs that jurisdictions are required to submit under this agreement. Specific geographic areas that fail to meet the objectives of the Agreement, where such failure has caused or is likely to cause the impairment of beneficial uses or the area's ability to support wildlife, are to be designatarea's ability to support wildlife, are to be designated as 'Areas of Concern'. RAP that embody 'a systematic and comprehensive ecosystem approach to restoring and protecting beneficial uses' are to be prepared for these areas. The investment being put into the RAPs provides Governments and indiput into the RAPs provides Governments and indi-vidual communities with a substantial base for moving forward into the future. There has been real achievement in bringing people together to address common problems across the usual agency, level of government, topical, environmental media, disciplinary, business-government and other insti-tutional barriers. (See also W91-11003) (Lantz-PTT) W91-11019

PROVINCIAL GUIDELINES TO GREAT LAKES SHORELINE MANAGEMENT PLANS.
Ontario Ministry of Natural Resources, Toronto.
Conservation Authorities and Water Management Branch

P. L. McKeen, and M. N. Law.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 205-211, 1 ref.

Descriptors: \*Environmental protection, \*Great Lakes, \*Lake shores, \*Land use, \*Provincial juris-diction, \*Regulations, \*Shoreline Management Plan, Canada, Erosion, Flooding.

In December 1986, a provincial shoreline management program was established with the Ministry of Natural Resources being named the lead ministry responsible for overall program administration and conservation authorities the lead implementing agency where they exist. The key components of agency where they exist. The key components on the program include the preparation of a policy statement identifying shoreline hazards as a matter of provincial interest, hazard mapping, plan input and review, increased public information and edu-cation initiatives, emergency response funding to provide technical advisory services during the

## Field 6—WATER RESOURCES PLANNING

## Group 6E-Water Law and Institutions

high water period and the preparation of shoreline management plans. In August 1987, the Conservation Authorities and Water Management Branch of the Ministry of Natural Resources produced and circulated Guidelines to assist the local implementing agencies in preparing Shoreline Management Plans. The major goals of a Shoreline Management Plan were defined as minimizing danger to life and property from flooding pression and associated property from flooding, erosion and associated hazards along the shorelines of the Great Lakes-St. Lawrence River system, and to ensure that shoreline development adequately addresses flooding and erosion hazards through a combination of public and private management and development and erosion hazards through a commination of public and private management and development alternatives. The Guidelines for Developing Great Lakes Shoreline Management Plans, in general, have provided sound overall direction to local implementing agencies in the preparation of shore-line management plans. Despite the broad nature of the planning process identified, the Guidelines have been developed in such a manner so as to provide sufficient flexibility to recognize unique or specific shoreline characteristics. Strengthening specific shoreline characteristics. Strengthening the Guidelines through periodic revisions in rethe Cuucines through periodic revisions in re-sponse to shifts in policy direction, advances in technical knowledge and understanding of coastal processes, and changes in legislative and adminis-trative implementation mechanisms will ensure the continued viability and utility of all Shoreline Management Plans. (See also W91-11003) (Lantz-PTT). PTT) W91-11024

BREAKING THE INCREMENTALIST TRAP: ACHIEVING UNIFIED MANAGEMENT OF THE GREAT LAKES ECOSYSTEM. Cornell Univ, Ithaca, NY. Dept. of Civil and Environmental Engineering. For primary bibliographic entry see Field 6A. W91-11025

FLUCTUATING WATER LEVELS IN THE GREAT LAKES-ST, LAWRENCE RIVER BASIN: AN EVALUATION FRAMEWORK FOR THE ANALYSIS OF POTENTIAL ACTIONS, Corps of Engineers, Buffalo, NY. Buffalo District. For primary bibliographic entry see Field 6B. W91-11026

GREAT LAKES WATER LEVELS MANAGE-MENT: RELAXING THE 'POLICY TRAP'.

Toronto Univ. (Ontario). Inst. for Environmental Studies.

For primary bibliographic entry see Field 6A. W91-11027

FLUCTUATING GREAT LAKES LEVELS: PROGRESS AND OPPORTUNITIES. International Joint Commission-United States and

Canada, Ottawa (Ontario).
For primary bibliographic entry see Field 6A.
W91-11032

FLUCTUATING WATER LEVELS: AN ISSUE MANAGEMENT APPROACH. Guelph Univ. (Ontario). Dept. of Geography For primary bibliographic entry see Field 6B.

LIMITS OF GOVERNMENT RESPONSIBIL-

TTY.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics.
L. Shabman, and W. Shoots.
IN: International and Transboundary Water Resources Asso-

sources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 309-318, 33

Descriptors: \*Decision making, \*Government supports, \*Great Lakes, \*Institutional constraints, \*Water resources management, Canada, Public policy, Resources management, United States.

Government action begins from a base of current policy which reflects it's evolution over time. Policy reflects the government viewpoint, sets

goals and sets constraints on government action and responsibility. Several main themes may be discerned (explicitly and implicitly) in U.S. and Canadian federal water management policy. Gov-ernments seek to promote informed and responsi-ble decision making by interests and to assure resiliency of interests to natural hazards. Governresiliency of interests to natural hazards. Governments also promote economic development, bounded by environmental protection, and seek a planning process giving multiple interests access to the decision making process. These broad policy themes serve to define the nature and scope of government responsibility. In making generalizations about positions of government (i.e. policy), liberties of interpretation are unavoidable and the interties of interpretation are unavoidable and the presence of exceptions must be acknowledged. Indeed, it is the exceptions which demonstrate the main policy themes. Thus, for example, the resist-ance of governments to expanding post disaster aid (despite its existence) and the increased insistence on cost recovery (in the US) for hazard reduction projects (despite a policy of less than full cost recovery), demonstrate the policy presumption in favor of informed and responsible decision making. Acknowledging these limits on the ability to gener-alize, there remain key themes of policy which must be recognized in describing the position of governments. (See also W91-11003) (Lantz-PTT) W91-11034

WHAT STAKEHOLDERS WANT AND WHY. Gore and Storrie Ltd., Toronto (Ontario). For primary bibliographic entry see Field 6A. W91-11035

INSTITUTIONAL MORASS: CONSTRAINTS AND OPPORTUNITIES FOR ISSUE MANAGE-

AND OFFORMAN MENT. National Oceanic and Atmospheric Administra-tion, Ann Arbor, MI. Great Lakes Environmental Research Lab.

For primary bibliographic entry see Field 6A. W91-11036

SO WHAT, FINDINGS AND RECOMMENDA-TIONS FROM THE LAKE LEVELS STUDY. Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics. For primary bibliographic entry see Field 6A. W91-11037

WATERSHED YEARS AT NIAGARA FALLS: CANADIAN AND AMERICAN POLICY RE-SPONSES TO NEW MEANINGS OF POWER, 1905-1914.

California Univ., Santa Barbara. Dept. of History. G. Evans.

IN: International and Transboundary Water Re-sources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 349-357, 33

Descriptors: \*International agreements, \*Interna-tional waters, \*Niagara Falls, \*Public policy, \*Water resources management, Burton Act, Canada, Legislation, Ontario Hydro Commission, Social aspects, United States.

At the opening of the twentieth century, Niagara Falls became a grand amphitheater where dynamic cultural, economic, and political forces all converged. For generations a cultural icon and source of spiritual inspiration, Niagara became a stage setting for one of North America's earliest and most intense battles over the use and preservation of Niagara's valued resources of power. On both sides of the United States-Canadian border, corporate leaders, public officials, and concerned citizens debated the question of who should control and benefit from the Falls' multiple meanings of power. In response to separate but equally vigorous popular public crusades in the United States and Canada, the Ontario, government came to exert far greater control than ever before over both the aesthetic and utilitarian resources of power at Ni-agara. Passage of the 1906 Burton Act and legislation creating the Ontario Hydro Commission in 1906 testify to the new involvement of government in formulating public policies to manage the flow

of water over the Falls. (See also W91-11003) (Author's abstract) W91-11038

MILK RIVER: HISTORICAL TRANSITIONS IN AN INTERNATIONAL WATERWAY.

Montana State Univ., Bozeman. Water Resources Research Center. M. F. Wolfe.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 359-371, 1 fig, 31 ref.

Descriptors: \*Alberta, \*Conflicting use, \*History, \*International waters, \*Milk River, \*Montana, \*Water resources development, \*Water resources management, Canada, Federal jurisdiction, Inter-national agreements, Legislation, Public policy, United States, Water rights.

An examination of the manner in which the United States and Canada settled their respective portions of the Milk River basin, reveals the historical similarities and differences that characterized the delarities and differences that characterized the development of the region on both sides of the 49th parallel. Encouraged by government policies and by two railroads, settlers came into this isolated prairie region and water disputes soon erupted. These disputes provoked two far-reaching decisions: the US Supreme Court's Winters decision in 1908, which granted reserved water rights to the Ft. Belknap tribe; and the Boundary Waters Treaty of 1909, which apportioned the waters of the Milk between Canada and the United States. Since that time, water development in the American portion of the basin has proceeded largely without regard either for undeveloped tribal reserve water rights or for Alberta's undeveloped share of the river. In the face of recurring water shortages in Montana's segment of the river, two native groups and the segment of the river, two native groups and the province of Alberta now plan to develop their unused share of the river. In an attempt to avoid further conflicting use, a number of possible solu-tions have been proposed, but all are founded on assumptions very different from those which gov-erned in the past: a more comprehensive basinwide management scheme and improved water use efficiency. The three phase 'comprehensive plan' proposed to Montana irrigators by state and federal water managers includes: (1) a joint board of control for better basin-wide management; (2) recontrol for better basin-was management; (2) re-habilitation of the irrigation system and improved on-farm irrigation techniques for better water use efficiency; (3) if necessary and politically feasible, a new water diversion from the Missouri River; and (4) a possible rental agreement between state irri-gators and Alberta who has offered to lease storage space in the new reservoir to Montana. After age space in the new reservoir to Montana. After 100 years of shared use of the Milk River, the goal of these plans is to find a way to provide water to all those who are entitled to it. (See also W91-11003) (Lantz-PTT)

INTERPROVINCIAL WATER MANAGEMENT IN WESTERN CANADA.

Prairie Provinces Water Board, Regina (Saskatche-

R. L. Kellow.

IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 373-381, 3 fig,

Descriptors: \*Canada, \*Governmental interrela-tions, \*Provincial jurisdiction, \*Water resources management, Alberta, Interagency cooperation, Interprovincial commissions, Legislation, Manito-

Prior to 1930, the right to use water in the prairie provinces of Alberta, Saskatchewan and Manitoba was administered by the Government of Canada. In 1930, the administration of these rights was nsferred to individual provinces. Because most of the region's major streams flowed across political boundaries, the need for a cooperative approach to water management was required. The Governments of Canada and the three provinces

## WATER RESOURCES PLANNING-Field 6

## Water Law and Institutions—Group 6E

established the Prairie Provinces Water Board by signing the Master Agreement on Apportionment in 1969. This Agreement set out an apportionment formula for the sharing of the natural flow of transboundary waters. The Agreement also established interprovincial water quality management within the Board's mandate. The Board has developed water quality objectives and a monitoring program along the interprovincial boundaries. The Board is also actively involved in interprovincial groundwater management and the maintenance of a water use database. Despite the fact that the Board does not have any legislative basis for enforcing its mandate, it has been successful in the administration of the Master Agreement. While this success can be attributed to a number of factors, the spirit of cooperation which exists among the members of the Board and its committees has proven to be the critical factor. (See also W91-11003) (Author's abstract)

WILL FREE TRADE DRINK CANADA DRY. Department of the Environment, Ottawa (Ontario). Inland Waters Directorate. For primary bibliographic entry see Field 6D. W91-11041

COMPARATIVE WATER MANAGEMENT: A TALE OF TWO COMPACTS. Central Michigan Univ., Mount Pleasant. Dept. of Business Law and Regulation. For primary bibliographic entry see Field 6A. W91-11042

MANAGING TRANSBOUNDARY WATER DI-VERSIONS: EXPERIENCE FROM A PRIVATE UTILITY. Hackensack Water Co., Harrington Park, NJ. Research and Development Div. For primary bibliographic entry see Field 6A. W91-11045

NEW YORK CITY'S DELAWARE RIVER BASIN SUPPLY-A CASE STUDY IN INTER-STATE COOPERATION-.
New York City Bureau of Water Supply.
J. P. Conway, and R. Hurwitz.
IN: International and Transboundary Water Resources Issues. American Water Resources Association, Bethesda, Maryland, 1990. p 439-452.

Descriptors: \*Delaware River Basin, \*Institutions, \*Interstate compacts, \*New York City, \*Water resources management, \*Water supply, Delaware, Interstate commissions, New Jersey, New York, Pennsylvania, Regulations.

The turn of this century saw New York's demand for water increasing rapidly. This was due to large immigration and the merging of Brooklyn, which is across the East River from Manhattan, with New York City. The City decided to solve its water problems by expansion of the system. In 1961, the Delaware River Basin Commission (DRBC) was formed by the Delaware River Basin Compact, approved by the four states (NJ, NY, PA, DE), and enacted into law, this being the first time that an interstate water agreement on the Delaware River was approved by all the states. There were to be five commissioners, four comprising the governors of each basin state, and one presidential appointee, as representative of the Federal interests. In addition, the mayors of the cities of Philadelphia and New York would be advisors to the Commission. In 1978, at the initiative of the Commonwealth of Pennsylvania, the Delaware River Basin Commission adopted a resolution inviting each of the parties to the 1954 Supreme Court Decree to enter into serious, good daith discussions to establish the arrangement, procedures and criteria for management of the waters of the Delaware Basin. Fourteen recommendations were made which could be grouped into four major categories: (1) drought management; (2) new projects; (3) providing for, and managing, new demands; and (4) identifying and correcting existing problems. The recommendations were adopted by the Commission, after public hearing. Current-

ly, the main source of supply for the City is surface water impounded in three separate upland reservoir systems: the Croton, the Catskill, and the Delaware. The combined systems include 18 storage reservoirs and three controlled lakes having a total capacity of approximately 550 billion gallons. Water is conveyed to the City from the reservoirs in the Croton, Catskill, and Delaware Systems by gravity through large aqueducts and balancing reservoirs. Within the City, water is distributed through two major tunnels and four distribution facilities. (See also W91-11003) (Lantz-PTT)

WATER DIVERSION FROM THE GREAT LAKES AS A DYNAMIC GAME.
Minnesota Univ., St. Paul. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 6B.
W91-11051

Environmental Protection Agency, Washington, DC. Office of Water Supply.
Available from the National Technical Information Service, Springfield, VA. 22161, as PB90-141003. Price codes: A03 in paper copy, A01 in microfiche. Report No. WH-556, January 1989. 31p, 7 fig.

NONPOINT SOURCES: AGENDA FOR THE

Descriptors: \*Clean Water Act, \*Legal aspects, \*Legislation, \*Nonpoint pollution sources, Federal jurisdiction, Institutions, State jurisdiction, Water pollution sources.

In 1987, Congress shifted from fifteen years of nonpoint source (NPS) pollution planning and problem identification (1972-1987) to a new National NPS action program. The Act placed special emphasis on NPS by moving the provision from Title II (Grants for Construction of Treatment Works) into Title III (Standards and Enforcement), and by strengthening the basic Declaration of Goals and Policy in 101(a) of the Clean Water Act. The law and its legislative history expressed the intent that Federal and State governments should develop new institutional arrangements and come up with a better division of roles and responsibilities to get the job done. Consistent with 319, States are completing their assessments and management programs, which, after EPA review and approval, will serve as the cornerstone of the National NPS program in the years to come. This National NPS Agenda forms the framework for the National NPS program over the next five years, and will be supplemented by annual EPA work programs that provide additional, detailed information. (Author's abstract)

SOIL CONSERVATION SERVICE AND EXTENSION: COOPERATING TO ENHANCE SERVICES (MES PORTION).
P. J. Borich.

P. J. Borich.

IN: Agrichemicals and Groundwater Protection:
Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 125-128.

Descriptors: \*Administrative agencies, \*Nonpoint pollution sources, \*Soil conservation, \*Water conservation, \*Water resource institutes, Agricultural runoff, Cooperative Extension Service, Education, Groundwater quality, Pesticides, Soil Conservation Service, Water quality, Water quality management.

The United States Department of Agriculture (USDA) Nonpoint Source Water Quality Policy and the USDA Policy for Ground Water Quality established policy to integrate surface and ground-water quality protection and improvement into appropriate programs and activities. The reasons for these policies is the growing national concern about the quality of water. Nonpoint source pollution is a significant problem, and agriculture is a potentially major contributor. A Memorandum of Understanding (MOU) was signed in June 1988 which identified the roles of the Cooperative Extension Service (CES) and the Soil Conservation

Service (SCS) in the Strategy for Implementation of USDA Water Quality Policies. The policies provide background and guidance for agency relations in administering water quality policies. The CES has the major responsibility for public education programs based on research information while the SCS, in cooperation with Conservation Districts, will provide technical assistance for implementing soil and water conservation programs. Specific roles are defined for each agency in each of the following areas: (1) toxic substances (i.e., pesticides, household chemicals, wastewaters and sludges, and landfills); (2) both agricultural and non-agricultural nutrients and organics (e.g., chemical fertilizer management and organics (e.g., chemical fertilizer management and viruses (e.g., animal and human wastes); (4) agricultural and nonagricultural sources of salinity; and, (5) agricultural, silvicultural, and construction sources of sediment. (See also W91-11162) (Korn-PTT)

COORDINATING ROLES AND SERVICES: SOIL CONSERVATION SERVICE AND EXTENSION SERVICE,

D. G. Burns

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 129-131.

Descriptors: \*Management planning, \*Nonpoint pollution sources, \*Soil conservation, \*Water conservation, \*Water quality control, Administrative agencies, Federal jurisdiction, Institutions, Interagency cooperation, Local governments, State jurisdiction, Training, Water quality, Water resources institutes.

The process of coordinating the roles and services in the Soil Conservation Service (SCS) and Extension Service (ES) involves three major components. The first component involves the incorporation of nonpoint pollution control into the United States Department of Agriculture (USDA) National Conservation Program (NCP). That program provides guidance to each USDA agency involved in the protection and wise use the United States'soil, water, and related resources. A second component involves the establishment of institutional relationships—relationships among the Federal agencies, relationships within the USDA, and relationships with state and local governments. The SCS is in the process of finalizing an agreement with the Environmental Protection Agency (EPA) which will define the respective roles in agricultural NPS pollution control. SCS technical personnel are on assignment in each of the 10 EPA regions and state water quality agencies. The third component involves activities associated with the Water Quality Action Plan. The plan focuses on two major areas; (1) the development and updating of Field Office Technical Guides (FOTGs) including the incorporation of water quality considerations into conservation practice standards; and (2) the SCS will soon be starting a cooperative effort to identify water quality training needs and the development of training materials to address those needs. The initial emphasis will be on pesticide and nutrient management practices. (See also W91-11171) W91-11171

WELLHEAD PROTECTION-INFORMATION AND RESOURCES.

For primary bibliographic entry see Field 5G. W91-11172

FUNDING GROUNDWATER PROTECTION PROGRAMS: IOWA'S GROUNDWATER PROTECTION FUND.

Iowa Dept. of Environmental Quality, Des

Noines.

For primary bibliographic entry see Field 5G.

W91-11179

MINNESOTA CLEAN WATER PARTNERSHIP PROGRAM.

## Field 6—WATER RESOURCES PLANNING

## Group 6E-Water Law and Institutions

Minnesota Pollution Control Agency, Roseville. For primary bibliographic entry see Field 5G. W91-11181

WISCONSIN'S RISK ASSESSMENT BASED NUMERICAL GROUNDWATER STANDARDS PROGRAM

Wisconsin Div. of Health, Madison. Section of Environmental and Chronic Disease Epidemiology. For primary bibliographic entry see Field 5G. W91-11183

IN THE LAND OF THE GIANTS: GRASS-ROOTS ORGANIZING IN CALIFORNIA'S CENTRAL VALLEY.

For primary bibliographic entry see Field 5G. W91-11205

PAST, PRESENT, AND FUTURE OF WATER RESOURCES MANAGEMENT IN THE UNITED STATES.

American Water Resources Association, Bethesda, MD

For primary bibliographic entry see Field 4A.
W91-11207

FUTURE DIRECTIONS FOR WATER RE-SOURCES.

New Jersey Dept. of Environmental Protection, Trenton. Div. of Water Resources. For primary bibliographic entry see Field 4A. W91-11208

FUTURE WATER MANAGEMENT PROB-LEMS: THE FEDERAL ROLE IN THEIR SO-LUTION.

Colorado State Univ., Fort Collins. For primary bibliographic entry see Field 4A. W91-11210

DYNAMICS OF WATER POLICY. Florida Univ., Gainesville.

W. Viessman.

IN: A 25th Anniversary Collection of Essays by Eminent Members of the American Water Resources Association. AWRA Special Publication No. 89-2. American Water Resources Association, Bethesda, Maryland. 1989. p 41-47.7 ref.

Descriptors: \*Education, \*Federal jurisdiction, \*Political aspects, \*Water policy, \*Water resources development, \*Water resources management, Attitudes, Nonstructural alternatives, Public policy, Water conservation, Water law.

The water policies of the past were mainly development oriented. Today, water policy is focused on how to best manage this precarious resource. Major issues include: providing a national forum; providing regional forums; coordination of water resources place and programs educating the pulse. providing regional forums; coordination of water resources plans and programs; educating the public and decision makers; modernizing institutions and agency roles; paying for water management; blend-ing technology with public policy; defining benefi-cial use; protecting and enhancing the environ-ment; and addressing the problems of the future. Public views on water policy have changed signifi-cantly since the 1960's. Nonstructural management is stressed, new definitions of the beneficial use of water are emerging, and joint considerations of water are emerging, and joint considerations of land and water interactions are becoming more common in land and water resources planning processes. There is a need for effective regional planning and management. Better coordination planning and management. Detter coordination among planning agencies and greater consistency among plans is also a requisite. During the last decade, the Federal Administration and Congress have taken the view that the states should assume a greater portion of the national water management budget. It has not been as clear what the Federal role is to be. Comprehensive water resources plans should become the foundation for water resources coision making. Planning should be proactive, guide water management actions, and drive regulatory programs. The water policies of the future must take on a global dimension. Few contemporary problems are local in nature. More emphasis must be placed on regional planning and management and regional institutions to accommodate this must be devised. (See also W91-11206) (Mertz-PTT) W91-11212

LEGISLATIVE IMPLEMENTATION OF INTE-GRATED CATCHMENT MANAGEMENT IN WESTERN AUSTRALIA. Western Australia Univ., Nedlands. Faculty of

Environmental Planning and Law Journal EPLJEX, Vol. 7, No. 3, p 199-208, September 1990. 54 ref.

Descriptors: \*Australia, \*Environmental law, \*Public policy, \*Regulations, \*Water resources management, \*Watershed management, Catchment areas, Decision making, Legal aspects, Planning, Public participation, Water law.

The Western Australian government has defined Integrated Catchment Management (ICM) simply as the coordinated planning, use and management of water, land, vegetation and other natural resources on a river or groundwater catchment basis. Current legislation does not provide a basis for Current legislation does not provide a basis for developing a community approach to ICM, especially in respect to private rural land use. Land use is too complex to be regulated by a comprehensive legal code of management practices, for that reason the regulation of land use is achieved by a planning process which gives legal authority to the planning decisions. This discretionary management control of the property of the planning decisions. planning decisions. In its discretionary management permits flexibility in creating principles applicable to particular places and circumstances. In the Peel Inlet and Harvey Estuary some common law rights and duties have been abrogated by legislation which has resulted in administrative structures which rely on bureaucratic action. There needs to be better definition of the rights and duties of the interested parties and procedures by which those parties may cooperate in making resource planning and management decisions. (Doyle-PTT) W91-11374

SAJUNDWATER DEPLETION IN INDIA: IN-STITUTIONAL MANAGEMENT REGIMES. California Univ., Berkeley. Dept. of Forestry and Resources Management. For primary bibliographic entry see Field 4B. W91-11382

TENSIONS BETWEEN WATER LEGISLATION AND CUSTOMARY RIGHTS.
Melbourne Univ., Parkville (Australia). Center for

Natural Resources Law.

Natural Resources Journal NRJOAB, Vol. 30, No. 3. p 503-520, 1990.

Descriptors: \*Legal aspects, \*Water law, \*Water management, \*Water resources management, \*Water rights, Environmental policy, Riparian rights, Water policy.

To regard customary law as an impediment to modern, rational water management suggests a dis-tinction between less-developed and more-devel-oped systems of law. However customary law often has rich historical, cultural, religious, and orten has not nistorical, cultural, religious, and social roots. Further, the annoying, inconvenient features of customary law-its dynamism; its symbiotic relationship with the possibility of compensation; its tendency to equate dominion over land with dominion over water-are often present in more developed systems of law. The tension between customary and modern systems arises from tween customary and modern systems arises from their different notions of the private and public domains; their different ideas of ownership and its attributes. The insights of the Bruntland Commis-sion (sustainable development, inter-generational equity etc.) require more developed legal systems to limit and re-define the attributes of property. Notions of communal title, inalienability, trustee-ship, the unity of human kind and nature, of comship, the unity of human kind and nature, of communal not individual authority, and of a balance between personal desires and community obligations, underlie many customary systems. More developed legal systems and economic theorists are often uncomfortable with such notions. With an eye on the future, however, the question should not be how to make customary law conform to modern notions, but vice-versa. (Author's abstract) W91-11383

REGULATION OF INTERBASIN TRANSFERS AND CONSUMPTIVE USES FROM THE GREAT LAKES.

Natural Resources Journal NRJOAB, Vol. 30, No. 3, p 561-579, 1990. 3 tab.

Descriptors: \*Governmental interrelations, \*Great Lakes, \*Interbasin transfers, \*State jurisdiction, \*Water law, \*Water permits, \*Water policy, \*Water resources management, Great Lakes Char-ter, Interstate compacts, Judicial decisions, Lake agement, Water supply development.

The Great Lakes were an open access resource with respect to consumptive water use, prior to the promulgation of the Great Lakes Charter and the Water Resource Development Act of 1986. Concern about the open access nature of the lakes was sparked by the Sporhase v. Nebraska ex rel. Douglas Supreme Court Decision, which limited states' ver to prevent water transfers. The resulting binding Great Lakes Charter recommends a set nontoning Orea. Lakes Catalet recommends a set of management rules enforced through state water permits. However, not all Great Lakes States have implemented the Charter Provisions, and damages associated with lake water withdrawals are generally not accounted for by the permits. Because the charter recommends management by a standard (permits enforce some standard) without setting the standard, evolution towards a basin wide trans-(permits enforce some standard) without setting the standard, evolution towards a basin wide trans-ferable permit system is recommended. Transfera-ble permits would require the definition of a stand-ard but would result in a cost effective means of managing the lakes. (Author's abstract) W91-11384

MANAGING WATER RESOURCES IN LATIN AMERICA.

Economic Commission for Latin America and the Caribbean, Santiago (Chile). For primary bibliographic entry see Field 6B. W91-11385

RESALE OF THE COLUMBIA RIVER TREATY DOWNSTREAM POWER BENEFITS: ONE ROAD FROM HERE TO THERE.

Washington State Energy Office, Olympia. J. A. Lesser.

Natural Resources Journal NRJOAB, Vol. 30, No. 3, p 609-628, 1990. 1 fig, 3 tab.

Descriptors: \*Governmental interrelations, \*Hydroelectric power, \*International agreements, \*Treaties, \*Water resources management, Canadian Entitlement, Columbia River, Hydroelectric plants, International law, Legal aspects, Licens Water law, Water policy.

In 1964, Canada sold its share of the power provided by the Columbia River Treaty to the Unites States. That power called the Canadian Entitlement, has been used by Northwest utilities to helpmeet a steadily increasing demand for electricity. That power will be completely repartiated to Canada by 2003. Unless a new sale is arranged, the Pacific Northwest may have to replace as such as Pacific Northwest may have to replace as much as Pacinic Northwest may have to replace as much as 600 average megawatts of energy, and 1,400 megawatts of capacity. Debate on both sides of the border has already begun as to whether the Cana-dian Entitlement will be resold to the United States. Many potentially contentious issues were not envisioned in 1964. These issues include the mitigation of fish and wildlife in the Pacific Northwest, the expiration of the agreement that coordiwest, the expination of the agreement hat coordinates hydropower operations in the Northwest, and renegotiation of the downstream power benefits made possible by the treaty. The regional calculus with regard to power generation and the importance of environmental factors has changed considerably. Greater access to transmission facili-

## WATER RESOURCES PLANNING—Field 6

## Water Law and Institutions—Group 6E

ties, a changing regulatory structure, renewed con-cerns over environmental costs of electrical gen-eration, and potential changes to coordinated United States hydropower operations may have significant impacts on the magnitude and value of the Entitlement. (Doyle-PTT)

DANUBE RIVER BASIN: NEGOTIATING SET-TLEMENTS TO TRANSBOUNDARY ENVI-RONMENTAL ISSUES.

International Inst. for Applied Systems Analysis, Laxenburg (Asstria). For Applied Systems Analysis, For primary bibliographic entry see Field 5G. W91-11387

AGENCY AUTONOMY IN TRANSBOUNDARY RESOURCE MANAGEMENT: THE UNITED STATES SECTION OF THE INTERNATIONAL BOUNDARY AND WATER COMMISSION, UNITED STATES AND MEXICO.
Colorado State Univ., Fort Collins. Dept. of Politicisches

S. P. Mumme, and S. T. Moore. Natural Resources Journal NRJOAB, Vol. 30, No. 3, p 661-684, 1990, 2 tab.

Descriptors: \*International Boundary and Water Commis, \*International commissions, \*International law, \*Legal aspects, \*Mexico, \*Treaties, \*United States, \*Water law, \*Water resources management, Environmental policy, International agreements, Jurisdiction, Water policy.

On March 2, 1989, one of the most prestigious On March 2, 1989, one of the most prestigious international resource management agencies in the world celebrated a century of successful diplomacy. The International Boundary and Water Commission, now a century old, is an exceptional example of situated autonomy in the performance of an international resource management mandate. The United States Section's limited political and policy autonomy has served the Commission well, ena-bling it to functionally develop and better serve its clientele within the limits of the Commission's jurisdiction. This same autonomy limits the Commission's capacity for development in certain policy directions and provides a good case for a multi-agency approach to binational resource management. Nonetheless, at its centenary, the Commission deserves ample praise for its accomplish-ments and appreciation for the role it will play for both countries into the 21st century. It is an excelboth countries into the 21st century. It is an excei-lent exemplar to the world community of what can be accomplished in the border policy arena, sover-eignty and national imperatives notwithstanding. (Doyle-PTT) W91-11388

HONG KONG: CAN THE DRAGON CLEAN ITS NEST.

Hong Kong Univ. Centre of Urban Studies and Urban Planning. For primary bibliographic entry see Field 5G.

CROSSING THE NEXT MERIDIAN: SUSTAIN-ING THE LANDS, WATERS, AND HUMAN SPIRIT IN THE WEST.

Colorado Univ. at Boulder. School of Law.

C. F. Wilkinson. Environment ENVTAR, Vol. 32, No. 10, p 14-34, December 1990, 14 ref.

Descriptors: \*Resource management, \*Resources L'escriptors: \*Kesource management, \*Resources development, \*Water resources development, Environmental policy, Future planning, Long-term planning, Public lands, Range management, Regional planning, Water demand, Water use.

The simplicity that permitted the extraordinary 19th century federal and state expansionist programs in the American West has evaporated. The extreme laiseze-faire policies of the past along with federal and state subsidation of free mineral, timber, range and water rights has created complex problems all across the region. The West can no longer continue at the same pace the degradation

and consumption of natural resources. The ecoand consumption of natural resources. The eco-nomic and environmental ramifications of tradi-tional extractive development is obvious: rivers and lakes have evaporated, abandoned and work-ing mines emit toxic metals into aquifers and streams, oil reserves are permanently depleted, and clear-cutting of forests causes irreparable environ-mental harm. Most Westerners today believe that the extractive development of western resources is necessary and desirable but ought to be balanced, prudent, and reasonably stable. Sustainable devel-opment meets the needs of the present without endangering the ability of future generations to endangering the ability of future generations to meet their needs. It does not abuse people or resources. It does not exceed and must maintain the carrying capacity of the resource base. The transition to sustainability does not necessitate the sacrifice of all material comforts for a return to some style of subsistence living. However, it does require reexamination of modern society's habit of reaping the benefits now and postponing the costs. (Feder-PTT) W91-11440

REGULATORY REQUIREMENTS FOR PULP AND PAPER MILL EFFLUENT CONTROL: SCIENTIFIC BASIS AND CONSEQUENCES.

COWIconsult, Lyngby (Denmark). For primary bibliographic entry see Field 5G. W91-11470

GOALS, REGULATIONS AND INFORMATION NEEDS FOR WASTEWATER DISCHARGE MANAGEMENT-AN AMERICAN PERSPEC-

National Council of the Paper Industry for Air and Stream Improvement, Inc., New York. For primary bibliographic entry see Field 5G. W91-11471

DEVELOPMENT OF ENVIRONMENTAL CONTROL LEGISLATION AND EFFLUENT STANDARDS FOR AUSTRALASIAN WOOD PROCESSING INDUSTRIES.

Forest Research Inst., Rotorua (New Zealand). Wood Technology Div. For primary bibliographic entry see Field 5G. W91-11472.

ENVIRONMENTALLY DESIRABLE AP-PROACHES FOR REGULATING EFFLUENTS FROM PULP MILLS,

Sprague Associations Ltd., Guelph (Ontario). For primary bibliographic entry see Field 5G. W91-11504

TOXICS REDUCTION: THE LEGAL FRAME-

McNees, Wallace and Nurick, Harrisburg, PA. Water Pollution Control Association of Pennsylva-nia Magazine, Vol. 24, No. 3, p 7-9, May/June 1991.

Descriptors: \*Legal aspects, \*Legislation, \*Permits, \*State jurisdiction, \*Water pollution control, \*Water quality standards, Aquatic life, Litigation, Pennsylvania, Priority pollutants, Public health,

The goal of the federal Water Quality Act of 1987 is to substantially and expeditiously reduce the amount of toxic pollutants being discharged into the nation's waterways. In enacting Section 304(1), Congress intended to encourage states to control toxic discharges to polluted surface waters. Pennsylvania codifies its water quality strategy at 25 PA Code Chapter 16, which specifies the guide-PA Code Chapter 16, which specifies the guide-lines and procedures for developing water quality criteria for toxic substances, and sets forth those criteria that have been established to date. As with the federal law, the Chapter focuses on priority pollutants. Chapter 16 contains guidelines for the development of criteria based on aquatic life and on human health. Aquatic criteria address both acute (short-term) and chronic (long-term) expo-sure to toxic substances and the consequences of such exposure. Human health-based criteria are

divided between threshold and non-threshold-level toxic effects. The area most open to legal challenge is the process by which the various rules and criteria are translated into effluent limitations for discharge permits. Because of manpower limitations and other reasons, the Department of Environmental Resources performs its modeling using ronmental Resources performs its modering using far less field data than any scientist would before making a decision. Thus, any permittee faced with effluent limits that it believes may not be justifiable should examine the analysis that generated those limits. (Doria-PTT) W91-11538

NEW STORM WATER REGULATIONS RE-QUIRE SIGNIFICANT COMPLIANCE AC-TIONS BY BOTH INDUSTRIES AND MUNICI-PALITIES.

BCM Engineers, Inc., Plymouth Meeting, PA. For primary bibliographic entry see Field 5D. W91-11541

TOXICITY REDUCTION EVALUATIONS (TRE'S) AS A TOOL FOR MEETING EFFLUENT STANDARDS.

J. R. Reed.

Water Pollution Control Association of Pennsylva-nia Magazine, Vol. 24, No. 3, p 46-47, May/June

Descriptors: \*Effluent limitations, \*Regulations, \*Water pollution control, \*Water quality standards, Administrative agencies, Chemical analysis, Cost analysis, Economic aspects, Enforcement, Legal aspects, Legislation, Pennsylvania, Permits, Wastewater treatment. Wastewater treatment.

Federal regulations require that states identify all Federal regulations require that states identify all waters impaired by point sources and develop individual control strategies (ICSs) for those point sources within a specific time frame. One method to control the discharge of toxics is the Toxicity Reduction Evaluation (TRE). When specific chemical or toxicity tests show that a discharge is excessively toxic, the state agency responsible for the permit can require the permitte to take action. the permit can require the permittee to take action to prevent adverse effects on the receiving waters. In evaluating toxics reduction, the Pennsylvania Department of Environmental Resources (DER) Department of Environmental Resources (DER) requires detailed chemical analyses of the effluent as part of a 3-step process to (1) verify the extent of the toxic pollutants in the wastewater; (2) determine their sources; and (3) recommend necessary control and treatment practices to achieve compliance. The TRE may identify a remedial action as simple as 'housekeeping' or a modification of plant operations. On the other hand, for complex facilities with numerous or variable wastestreams, a TRE may involve extensive investigation to identification. TRE may involve extensive investigation to identi-fy the toxic constituents and selection of the most ry the toxic constituents and selection of the most cost-effective treatment or source reduction options. The final aspect of controlling toxics is compliance with scheduling and examination of the antibacksliding regulations designed to force action. TREs will lead to changes in permit regulations as they expand our scientific data base on toxics and new treatment technologies. (Doriatoric data abase of the control of the cost of the PTT W91-11542

EVOLUTION OF NEVADA'S WATER LAWS, AS RELATED TO THE DEVELOPMENT AND EVALUATION OF THE STATE'S WATER RE-SOURCES, FROM 1866 TO ABOUT 1960.

Geological Survey, Carson City, NV. Water Resources Div.

H. A. Shamberger.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Bulletin 46, 1991. 100p, 2 fig. 4 tab, 6 append.

Descriptors: \*Nevada, \*Water law, \*Water resources management, Groundwater resources, Hydrologic budget, Legal aspects, Legislation, Sur-

This report describes the evolution of surface water and groundwater law in Nevada, beginning

## Field 6-WATER RESOURCES PLANNING

## Group 6E—Water Law and Institutions

in 1866 (2 years after statehood), and recounts the problems confronted by the Nevada State Engineers in connection with the development of Nevada's water resources from 1903, when that office was created. The Nevada statutes from statehood in 1864 to 1903 contain only three acts relating to underground water, whereas 20 statutes relating to surface water were enacted during this same time period. These three statutes were enacted in 1879, 1887, and 1901 and provided bounties for the development of artesian water. The early legislatures seemed to construe artesian water as water under free flow. In other words, a well would have to be a flowing well to be classified as an artesian well.

The State of Nevada first took cognizance of un-The State of Nevada first took cognizance of underground water as belonging to the public and subject to appropriation when it enacted a new water law in 1913. The first legislative act relating to the administration of underground water was contained in Chapter 210, Statutes of 1915, and remained in force until repealed by the more detailed groundwater law of 1939, which eliminated the reference to percolating water and made all groundwater, capable of being developed, subject to the appropriation laws of the State. The programs of stream gaging and groundwater studies by the US Geological Survey in cooperation with the Office of State Engineer are discussed from the State perspective. The Carey Act and its application to the reclamation of desert lands in Nevada also is described. (Lantz-PTT) also is described. (Lantz-PTT)

PHOTOGRAPHS WRITTEN HISTORICAL AND DESCRIPTIVE DATA. National Park Service, San Francisco, CA. West-

ern Region.
D. M. Introcaso.
Report No. HAER No. AZ-25, 1990. 167p, 70

photos, 60 ref, 3 append.

Descriptors: \*Competing use, \*Salt River Project, \*Verde River Basin, \*Water law, \*Water resources development, \*Water rights, Legal aspects, Political aspects, Social aspects, Water supply.

The Salt River Valley Water Users' Association always assumed it was the Salt River Project's right to develop the Verde River, against the wishes of the Verde River Irrigation and Power District. The Salt River Project's diversion works at Granite Reef were built below the confluence of at Granite Reef were built below the confluence of the two rivers which furthered their view that it was an intimate part of the Salt River system. Even though the Reclamation Service had never engineered a storage dam on the Verde for the Project, the Interior Department did withdraw the Verde for public entry for the purpose of creating the Salt River Project, and both the United States and the Association filed for surplus Salt and Varda River water in 1906, one were received to Verde River water in 1906, one year prior to the construction of the Project's Granite Reef Dam in 1907. Even before the Association took over operaintenance of the Salt River Project in 1917, it filed for rights to the Verde's Horseshoe dam site in 1914. The numerous consulting engineers were the most persistent players throughout the Verde's development history; their work framed the issue and gave it definition. Generally, the engineers served the interests of organizations which employed them which may explain the diviwinch employed them which may explain the divi-siveness of opinion among them concerning the viabality of the Verde to support an independent irrigation project. The federal government's role in the outcome of the Verde's development was the most critical; it decided the issue. Therefore, what decided the development of the Verde was not the deterministic of any one projection concert. The determination of any one engineering report. The question was not whether the Verde's hydrologic record showed that there was sufficient water for a certain acceptable number of acres or whether the Assocation 'wasted' over half its water supply. It was not the federal government meeting its obliga-tion to provide water to the Salt River Indiansmeeting Indian water demands in central Arizona meeting indian water demands in central Arizona never took precedence. It was not the Depression which preempted to the issue, causing federal ef-forts to build Bartlett Dam to provide emergency work relief. Nor was it settled by judicial decree, because no party was truly interested in risking their future to a court order. Finally, the Verde's development was not the evenetual or inevitable

product of environmental necessity--the historical necessity of central Arizona's need for an ever necessity of central ATIZONA'S need for an ever increasing water supply. Bartlett Dam was built because the Salt River Valley Water User's Association proved more politically powerful then the Verde River Irrigation and Power District. This report chronicles the Salt River Project through photographs and written historical data. (Lantz-

### 6F. Nonstructural Alternatives

IMPROVED POLICY INSTRUMENTS FOR MANAGEMENT OF ENCLOSED COASTAL SEAS AND ESTUARIES: THE CHESAPEAKE

BAY, USA. Maryland Univ., Solomons. Center for Environmental and Estuarine Studies.
For primary bibliographic entry see Field 2L.
W91-10610

LEGAL SYSTEM AND MANAGEMENT OF SOUTHERN FRANCE LAGOONS.

Toulouse-1 Univ. (France).
For primary bibliographic entry see Field 5G.

FLOOD-HAZARD ZONATION IN ARID LANDS.

Geological Survey, Tucson, AZ.
H. W. Hjalmarson.
Transportation Research Record TRREDM, No. 1201, p 1-8, 1988. 15 fig, 1 tab, 13 ref.

Descriptors: \*Arid lands, \*Erosion, \*Flood control, \*Flood plain zoning, \*Sediment transport, Flood frequency, Flood plain management, Flow pattern, Geomorphology, Runoff, Sheet flow, Stream channels.

Potential flood hazard in arid southern and western Arizona stem from different geomorphic and hydrologic characteristics and can be grouped into nydrologic characteristics and can be grouped into zones. The zonation is based on the physical fea-tures of the terrain, the sources of flooding, the expected frequency of flooding, and the expected erosion and sediment deposition. Geomorphology plays an important role in determining flood hazard. Although this fact is common knowledge, structures continue to fail or become less effective. structures continue to fail or become less effective. at least in part because of flood plain management regulations that may not be applicable for some zones. The hazards that commonly plague engi-neering works are the lateral bank erosion in zone 2, the scour of channel beds in zone 1, and the sediment deposition and unpredictable flow paths in zone 4. The zonation is based on distinct geomorphic and hydrologic differences between the zones, but there is some overlap. Zones 2 and 3, for example, can define the hazard of the same land where there is a potential for lateral movement of the banks of channels in zone 1 and also for sheet-flow from local rainfall or from runoff from zones 4 or 5. Alluvial fans have a wide variety of flood characteristics, and thus specific areas can be best described by zones 3, 4, or 5. In general, large areas of fans will exhibit characteristics of a single zone. This general zonation is not intended to replace the detailed engineering definition of hydrologic and geologic characteristics of a particular site of interest. Rather, the zonation of flood hazards can be useful to practicing engineers for the general identification of the type and degree of flood hazard. (Lantz-PTT) W91-11390

#### LAND TENURE ISSUES IN WATERSHED DE-VELOPMENT.

In: Watershed Development in Asia: Strategies and Technologies. World Bank Technical Paper No. 127. World Bank Publications, Washington, DC. 1990. p 131-158, 2 tab, 76 ref, append.

Descriptors: \*Asia, \*Conservation, \*Land tenure, \*Land use, \*Literature review, \*Political aspects, \*Watershed management, Developing countries,

Legal aspects, Population density, Productivity, Soil conservation, Water conservation.

In order to document why tenure is relevant to watershed projects and to provide a conceptual framework for making decisions related to tenurial framework for making decisions related to tenurial issues during project design, a review of the literature has been made regarding land tenure and conservation, as well as a review of relevant projects in China, India, Indonesia, Nepal, the Philippines, and Thailand. Watershed development projects aim at improving the overall productivity, sustainability, and equity of land use in fragile, arable, and nonarable lands. Some of the most familiar land tenure systems in Asia are: water. arable, and nonarable lands. Some of the most familiar land tenure systems in Asia are: water-sheds with relatively stable land tenure systems (Java, Taiwan); watersheds with relatively ancient, state-recognized land tenure systems (Burma, China, India, Nepal); and watersheds in 'frontier' areas (Philippines). Population density is extremely important in determining land use in much of Asia. The data are ambiguous regarding the effect of tenure on adoption rates in ongoing or completed watershed projects and the analysis has been confused by a number of factors, such as quality of the technology packages, subsidies, and lack of knowltechnology packages, subsidies, and lack of knowledge about the land tenure situation in project edge about the land tenure situation in project areas. A significant problem with attempts to evaluate the effects of land tenure is that studies have been too simplistic. Some positive measures that can be included in projects to support land tenure changes or to broaden the range of adoption within existing tenure systems include: providing increased extension support; providing sources of credit; focusing on technologies with quicker and high returns; strengthening local institutions; and providing mediation or legal aid to participants. The World Bank needs to continue to study the relationship between land tenure and the adoption relationship between land tenure and the adoption of soil and water conservation technologies, so that clearer directives can be given to task managers as to what strategies are most productive, sustainable, and equitable in the different Asian settings. (See also W91-11563) (Fish-PTT) W91-11569

## 6G. Ecologic Impact Of Water Development

RESEARCH ON CLOUDS AND PRECIPITA-TION: PAST, PRESENT AND FUTURE, PART

Washington Univ., Seattle. Dept. of Atmospheric

Sciences.
For primary bibliographic entry see Field 3B.
W91-10481

ESTIMATING THE EFFECTS ON THE RE-GIONAL PRECIPITATION CLIMATE IN A SEMIARID REGION CAUSED BY AN ARTIFI-CIAL LAKE USING A MESOSCALE MODEL. Uppsala Univ. (Sweden). Meteorologiska Institu-

For primary bibliographic entry see Field 2B. W91-10502

## EGYPTIAN APPROACH TOWARDS APPROPRIATE USE OF COASTAL ZONES ON THE RED SEA

Egyptian Environment Affairs Agency, Cairo. E. E. Eid, and M. A. Fawzi. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 331-337, 1991. 2 fig, 1 tab, 9 ref.

Descriptors: \*Coastal waters, \*Coastal zone management, \*Egypt, \*Red Sea, Corals, Economic aspects, Environmental monitoring, Environmental protection, Gulf of Aqaba, Mangrove trees, Oil spills, Public policy, Shores, Species diversity, Tourism, Water pollution control.

Environmental management and appropriate use of coastal zones is one of the major challenges facing Egypt, as a natural outcome of its strategic geographic location straddling both the Mediterranean and the Red Sea which constitute two of the major enclosed coastal seas in the world. The problem of the protection of the marine environment in the

## Ecologic Impact Of Water Development—Group 6G

Egyptian coastal zones is a primary and serious concern of the Egyptian authorities. As a major tourist and recreation area, due to its ecological and aesthetic value, and as a result of a number of environmental pressures including rapid development and oil pollution, a resource management and development plan for the South Sinai coastal zone area was proposed within an integrated Environ-mental Management Plan of the Egyptian coastal zones along the Red Sea. The Gulf of Aqaba coast has been zoned into tourism development areas, protected areas, and National Parks, which will ensure that representative, economic and biologically important ecosystems are preserved to guarcarry important ecosystems are preserved to guar-antee sustained tourism development in this unique area. Due to the oil pollution on the shoreline of the gulf, which endangers both the high coral species diversity and mangroves, pollution control measures are being implemented at the entrance to the Gulf of Aqaba. (Author's abstract)

IMPACT OF COASTAL DEVELOPMENT ON THE INFRALITIORAL ZONE ALONG THE SOUTHEASTERN MEDITERRANEAN SHORE OF CONTINENTAL FRANCE.

Nice Univ. (France). Marine Environment Lab. A. Meinesz, J. R. Lefevre, and J. M. Astier. Marine Pollution Bulletin MPNBAZ, Vol. 23, p

Descriptors: \*Coastal waters, \*Coastal zone development, \*Coastal zone management, \*Environmental effects, \*France, \*Mediterranean Sea, \*Shores, Artificial beaches, Benthos, Continental shelf, Dikes, Infralittoral zone, Land use, Landfills, Port facilities, Ports, Rocky shores, Shallow water, Species diversity

Numerous waterfront developments built on the sea along the southeastern French Mediterranean coast have resulted in large-scale destruction to the infralitoral zone. A total of 185 development projects, extending over 106 km have been built along the 656 km of rocky shores of the Provence-Alpes-Cote d'Azur region 30.57 sq km have been covered by ports, dikes, land fills, and artificial beaches. Because this region's coast has a very narrow continental shelf (only 314.72 sq km between 0 and -20 m), every construction on the sea significantly reduces the area where the benthic significantly reduces the area where the benthic life is richest in species diversity. Today, a total of 9.7% of the shallow water zone between 0 and -20 m and 14.5% between 0 and -10 m have been irreversibly destroyed by waterfront development.
(Author's abstract)
W91-10562

MODERN ENVIRONMENTAL ASSESSMENT PROCEDURES FOR ENCLOSED SEAS. Waikato Univ., Hamilton (New Zealand). Dept. of Earth Sciences

T. Healey, and K. Harada.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p. 355-361, 1991. 1 fig, 27 ref.

Descriptors: \*Baseline studies, \*Coastal waters, \*Enclosed seas, \*Environmental impact, \*Environmental monitoring, \*Future planning, \*Planning, \*Water resources management, Ecological distribution, Ecosystems, Environmental effects, Hydrodynamics, Inlets, Mathematical models, Model studies, Path of pollutants, Resource utilization, Sedimentation, Water pollution.

Enclosed seas on a world-wide scale are typically characterized by low tidal currents and flushing potential, yet are often centers of high population and, therefore, pollution pressure. Accordingly, recognized environmental assessment procedures are applied. For those examples which have little coordinated data, a full baseline environmental insectionities in peeded to, establish a data base. vestigation is needed to establish a data base against which future change can be measured. An integrated multi-disciplinary approach involves the integrated multi-disciplinary approach mivoves the following components: review of previous work and collation of existing data; bathymetric and geomorphologic evolution, and changes; determination of bottom sediment facies and sediment transport pathways and budgets; investigation of water column and surficial sediment geochemistry

and ecotoxicity; inlet hydraulics, tidal, current and and ecotoxicity; inlet hydraulics, tidal, current and wave climate measurements; investigation of marine biology and ecology, and the patterns of ecological distribution in relation to the sedimento-logic, oceanographic, and pollution parameters; numerical modelling of current hydrodynamics; numerical modelling of water quality and pollution dispersion; numerical modelling of hazards such as tsunamis, storm surge and flooding, and the effect of such events on the enclosed sea hydrodynamics, pollution and sediments; and review of the efficacy of the numerical models in relation to the field and politution and secuments; and review of the efficacy of the numerical models in relation to the field and empirical data. Only by undertaking an integrated, multi-disciplinary study can the best future planning decisions be made for resource utilization and management of the enclosed seas. (Author's abstract) W91-10564

TOWARD ENVIRONMENTAL PLANNING FOR EAST ASIAN ESTUARIES: JAPANESE AND CHINESE ENCLOSED BAYS,

Charles Envilosed BAYS.
Osaka Gejjutsu University, Department of Environmental Planning, Osaka Prefecture, 585 Japan.
For primary bibliographic entry see Field 2L.
W91-10565

ECOLOGICAL ASSESSMENT OF SEMI-EN-CLOSED MARINE WATER BODIES OF THE ARCHIPELAGO SABANA-CAMAGUEY (CUBA) PRIOR TO TOURISM DEVELOPMENT PRIOR TO PROJECTS.

Instituto de Oceanologia, Havana (Cuba). P. M. Alcolado.

Marine Pollution Bulletin MPNBAZ, Vol. 23, p 375-378, 1991. 2 fig, 7 ref.

Descriptors: \*Coastal zone management, \*Economic development, \*Environmental impact, \*Environmental protection, \*Tourism, \*Water resources management, Benthos, Bridges, Construction, Dam effects, Drought, Ecological effects, Freshwater, Highways, Phytoplankton, Population density, Precipitation, Reservoirs, Salinity, Sediments, Silt, Water exchange, Zooplankton.

The semi-enclosed marine water bodies of the Sabana-Camaguey Archipelago (north of Cuba) are the locations of extensive tourism development projects. Highways and bridges across these water bodies are being planned and constructed to reach and interconnect outer bordering keys. In order to evaluate any possible ecological impact and to elaborate recommendations for avoidance or minielaborate recommendations for avoidance or mini-mization of such impact, a multidisciplinary re-search program was planned. In some areas, high organic matter levels in sediments due to the weak circulation regime, which enhances accumulation processes, and high microbial mineralization rates, impoverish benthic assemblages. In some cases, where salinity reaches very high values, sediments are dominated by silt, or a combination of these are dominated by silt, or a combination of these two factors occur, ecological constraints exist. Phytoplankton and zooplankton show lower concentrations than expected in supposedly fertile semi-enclosed water bodies. Precipitation deficits during many years, combined with damming for fresh water storage, and natural limited exchange between inshore and oceanic water are responsible for observed ecological features. (Author's abstract) W91-10566

PARQUE DE DONANA', AND ITS CONTRI-BUTION TO ENVIRONMENTAL ACTIVITIES FOR ENVIRONMENTAL PROTECTION. Fundacion Jose Maria Blanc, Fortuny No. 27, 23010 Madrid, Spain. For tuny No. 27, For primary bibliographic entry see Field 5G. W91-10586

CONFIRMATORY CHEMICAL ANALYSES AND SOLID PHASE BIOASSAYS ON SEDI-MENT FROM THE COLUMBIA RIVER ESTU-ARY AT TONGUE POINT, OREGON.
Battelle Pacific Northwest Labs., Sequim, WA.
Marine Research Lab.
For primary bibliographic entry see Field 5B.
W91-10753

PACIFIC SALMON AT THE CROSSROADS: STOCKS AT RISK FROM CALIFORNIA, OREGON, IDAHO, AND WASHINGTON. For primary bibliographic entry see Field 8I. W91-10834

MACROINVERTERRATE RESPONSES ALONG A COMPLEX REGULATED STREAM ENVIRONMENTAL GRADIENT.

Colorado State Univ., Fort Collins. Dept. of Biol-For primary bibliographic entry see Field 4A. W91-10848

GREAT LAKES LEVELS AND FLOWS UNDER NATURAL AND CURRENT CONDITIONS. Inland Waters Directorate, Burlington (Ontario). Water Planning and Management Branch. For primary bibliographic entry see Field 2H. W91-11022

1987-89 DROP IN GREAT LAKES WATER LEVELS, CAUSES AND EFFECT.

Inland Waters Directorate, Burlington (Ontario). Water Planning and Management Branch. For primary bibliographic entry see Field 2H. W91-11023

EVALUATING THE IMPACT OF WATER QUALITY UPON THE VALUE OF RECREATIONAL FISHING.

Guelph Univ. (Ontario). Dept. of Agricultural Ecs and Business. D. P. DuPont.

IN: International and Transboundary Water Resources Issues. American Water Resources Asso-ciation, Bethesda, Maryland, 1990. p 565-574, 10

Descriptors: \*Fishing, \*Model studies, \*Recreation, \*Water quality, Economic aspects, Fishing fees, Social aspects.

del was developed that can be used to esti-A model was developed into an order to establish mate the demand for the number of lake-based recreational fishing trips to particular locations, as differentiated through various site-specific characteristics including water quality. An analyst can then use the demand function to determine the benefits associated with recreational fishing at specific locations. These benefits are approximated using consumer surplus. This is defined as the area under a demand curve evaluated from the obunder a demand curve evaluated from the ob-served quantity demanded up to the maximum price that an angler would be willing to pay for the first fishing trip minus actual trip expenditures. The demand curve can also be used to determine the demand curve can also be used to determine the maximum fee that a government agency could charge for the right to fish. By including water quality in the demand function, the analyst can observe how a change in water quality would alter the benefits from recreational fishing. If improved water quality is important to an angler, the marginal willingness-to-pay should be increased with improved water quality. This translates into a higher fee for locations with better quality water. These fees can help offset government expenses for improved water than the property of the contraction of the contra fees can help offset government expenses for improvements to water quality. (See also W91-11003) (Author's abstract)

STUDIES ON ASSESSMENT OF WATER BAL-ANCE AND ITS QUALITY IN GURPUR RIVER BASIN, KARNATAKA STATE, INDIA.

Mangalore Univ. (India). Dept. of Chemistry. For primary bibliographic entry see Field 5B. W91-11065

DAMS AND SUSTAINABLE DEVELOPMENT IN BRAZILIAN AMAZONIA.

Monosowski Associate Consultants, Sao Paulo For primary bibliographic entry see Field 8C. W91-11216

## Group 6G-Ecologic Impact Of Water Development

SOCIO-POLITICAL ASPECTS OF THE BOS-NAGYMAROS BARRAGE SYSTEM.

Regional Environmental Centre, Budapest (Hungary).
B. Borsos.

International Water Power and Dam Construction IWPCDM, Vol. 43, No. 5, p 57-59, May 1991. 1 fig, 1 tab, 7 ref.

Descriptors: \*Czechoslovakia, \*Dam effects, \*Environmental impact, \*Hungary, Bos-Nagymaros Project, Dams, Danube River, International agreements, Polano study, Političal aspects, Social aspects, Systems analysis, Water resources development.

The Bos-Nagymaros (BNB) project on the Danube River had been under way for some time, but until the late 1980s, no environmental impact assessment was done. In May 1989, Hungary unilaterally suspended all construction work on the Nagymaros cam. Later, work also was suspended at the Dunakiliti site of the Czechosolovia-Hungary Gabci-kovo-Nagymaros scheme (known in Hungary as Bos-Nagymaros or BNB). For almost 2 yr since then, no firm decisions have been taken on the fate then, no firm decisions have been taken on the fate susues raised by this project are: endangerment of both quality and quantity of groundwater supplies; impaired self-purification capacity of the Danube as a result of increased eutrophication; unavoidable deterioration of water quality; unknown geologic and seismic risks associated with the dams; dramatic transformation of the landscape with resulting social impact; and unfavorable economic impacts on activities such as agriculture and forestry. The first full analysis was conducted toward the end of 1989 using the Polano method. The study evaluated six areas: economics, ecology, water quality, politics, technical aspects, and miscellaneous. Three alternatives were considered: (1) completion of the whole system; (2) cancellation of the lower dam, Nagymaros, but completion of the upper part, including Bos and Dunakiliti; and (3) cancel the entire project. Ninety-six different factors were evaluated for each case. The results indicated that the best solution in the long term was cancellation of the whole system; (2) cancellation of the poper part, including Bos and Dunakiliti; and (3) cancel the entire project. Ninety-six different factors were evaluated for each case. The results indicated that the best solution in the long term was cancellation of the whole system; (2) cancellation of the bost observable changes, 16 benefits and 12 unknowns versus 77 unfavorable, 11 neutral, 6 benefits, and 2 unpredictable for case 1). Taking action on the results of the Polano study has been hampered by the ina

URBANIZATION AND URBAN WATER PROB-LEMS IN SOUTHEAST ASIA: A CASE OF UN-SUSTAINABLE DEVELOPMENT.

Malaya Univ., Kuala Lumpur (Malaysia). Inst. for Advanced Studies.

Advanceu Studies.
L. K. Sim, and G. Balamurugan.
Journal of Environmental Management
JEVMAW, Vol. 32, No. 3, p 195-209, April 1991.
6 tab. 28 ref.

Descriptors: \*Developing countries, \*Environmental effects, \*Urban development, \*Urban hydrology, \*Water pollution effects, Environmental quality, Flood damage, Population dynamics, Southeast Asia.

The urban water problems in Southeast Asian cities are viewed as the consequences of rapid and uncontrolled urbanization and unsustainable development. The pursuit of economic advancement has conjured a disregard for environmental conservation, which in turn has resulted in water problems of considerable magnitude. Despite the promulgation of laws and setting up of governmental agencies, the control of environmental degradation and enforcement of legislations have been slow due to budget and skilled manpower constraints. Moreover, the existing urban conditions do not allow for environmental improvement unless extensive funds are utilized for major urban improvements such as sewerage works, water supply and waste disposal. These improvements are not likely to happen in the near future. In the long-term, given the ever increasing urbanization and population

growth, the urban water problems in Southeast Asia are expected to escalate rather than attenuate unless serious planning and management are carried out. (Author's abstract) W91-1126.

EFFECT OF HYDROELECTRIC STATIONS ON WATER QUALITY AND DEVELOPMENT OF PHYTOPLANKTON IN THE LOWER POOLS OF RESERVOIRS.

L. A. Sirenko, A. I. Denisova, and M. N. Pakhmova.

Pakimova. Hydrotechnical Construction HYCOAR, Vol. 24, No. 6, p 384-388, December 1991. 6 tab, 16 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, pp. 22-25, June, 1990.

Descriptors: \*Dam effects, \*Hydroelectric plants, \*Limnology, \*Phytoplankton, \*Reservoirs, \*Soviet Union, \*Water quality, Algae, Biomass, Chlorophyta, Cyanophyta, Diatoms, Dinoflagellates, Dissolved oxygen, Hydrogen ion concentration, Photosynthesis.

Hydroelectric stations and their reservoirs have been criticized in recent publications in the Soviet Union. One question that has been raised is whether the lower pool becomes a 'dead' water hazardous for the ecosystem and water consumers. Onsite investigations conducted over the period 1982-1986 in the upper and lower pools of hydroelectric stations at Kiev, Kanev, and Kremenchug shed light on this issue. A monthly check of the biomass of algae generally did not show substantial quantitative differences in number and biomass between the upper and lower pools of reservoirs. No significant differences were noted in the qualitative composition of the phytoplankton in the upper and lower pools of reservoirs. Greens, blue-greens, dinoflagellates, and diatoms, typical representatives of the algal flora of the Dnepr River, were equally represented in the water. Neither the accumulation of dead algal cells and organic materials nor degradation of water quality occurs in lower pools as a result of the operation of turbine units. High photosynthetic activity of the algae in both the upper and lower pool can contain less dissolved oxygen and have a lower pH value, but this does not have a negative effect on indices of water quality and oxidative capacity. (Rochester-PTT)

AVALON LAKES: AN ENVIRONMENTAL OP-PORTUNITY.

A. T. Newman, and P. J. Hawker. Journal of the Institution of Water and Environmental Management JIWMEZ, Vol. 5, No. 1, p 66-71, February 1991. 2 fig. 1 tab, 2 ref.

Descriptors: \*England, \*Environmental effects, \*Marsh management, \*Peat bogs, \*Water supply development, Archaeology, Cost analysis, Lakes, Water quality.

The Avalon Lakes project, a concept to utilize shallow basins left by commercial peat exploitation as water storage reservoirs, was deemed too costly by the Wessex Water Authority which was preparing for privatization of the water industry. The engineering proposals for the project would have the lakes provide both flood alleviation and public water supply reservoirs. Secondary benefits would also accrue in the form of habitat restoration due to a reversal of the progressive decline of groundwater levels, and through opportunities for water-based recreation. To render the water from the lakes potable, a pilot-scale water treatment plant was added to the plans in 1986. Several public interest groups and professional consulting firms were involved in project design and evaluations and to assess the environmental impact of the Avalon Lakes project. Although the project was thought to be the best environmental alternative compared to other projects proposed, the costs of the project were not thought justified compared to the benefits. The marsh area will now be managed by local conservation groups until further plans are proposed. (Geiger-PTT)

TOWARDS MANAGEMENT OF ENVIRON-MENTAL PROBLEMS IN EGYPT.

Massachusetts Univ., Amherst. Dept. of Political Science.
P. M. Haas.

Environmental Conservation EVCNA4, Vol. 17, No. 1, p 45-50, 1990. 1 tab, 24 ref.

Descriptors: \*Egypt, \*Environmental policy, \*Management planning, \*Water pollution control, \*Water pollution prevention, Economic aspects, International agreements, Oil, Pesticides, Population dynamics, Public health, Sewage.

As a poor developing country, Egypt faces a wide variety of pollution problems that are associated with poverty. Widespread environmental problems are becoming acute, water pollution is seen as serious, and many new factories are being built without sufficient pollution controls. Consequently there are real threats to public health and agricultural productivity. Most of Egypt's major environmental problems stem from stretching its limited resource-base in order to accommodate the economic needs of its rapidly growing population. It is often difficult to consider non-quantifiable environmental factors in development planning, especially since Egypt suffers from lack of an integrated or comprehensive framework for conducting either economic planning or environmental policy. Although recent policy shifts are admirable, they are clearly insufficient to manage fully the wide range of environmental problems that now face Egypt Greater effort is demanded for the enforcement of Nile river controls, greater investment in oil reception facilities at ports to limit the amount of oil pumped from tanker's ballasts into the Eastern Mediterraen, reductions in government subsidies which encourage small farmers to use excessive amounts of pesticides, and changes in sewage treatment, industrial and domestic practices which all contribute to pollution. With financial assistance from USAID and USEPA, and at their behest, institutions have been developed, policies and legislation introduced, and budgets allocated, for a variety of forms of environmental protection. Greater amounts of foreign assistance will be required because of Egypt's limited range of financial resources. (Doyle-PTT)

CROSSING THE NEXT MERIDIAN: SUSTAINING THE LANDS, WATERS, AND HUMAN SPIRIT IN THE WEST.

Colorado Univ. at Boulder. School of Law. For primary bibliographic entry see Field 6E. W91-11440

ARAL SEA BASIN: A CRITICAL ENVIRON-MENTAL ZONE.

MENTAL ZUNE.
Akademiya Nauk SSSR, Moscow. Inst. Geografii.
V. M. Kotlyakov.
Environment ENVTAR, Vol. 33, No. 1, p 4-36,
January/February 1991. 1 fig., 1 tab, 5 ref.

Descriptors: \*Aral Sea, \*Descrification, \*Economic development, \*Irrigation effects, \*Water pollution effects, Agricultural runoff, Ecological effects, Fertilizers, Pesticides, Public health, Saline

The Aral, a large, desert-bound sea in south central Asia, was brought to life by the abundant Amu Darya and Syr Darya rivers, which drain into the Aral Sea basin from tributaries deep in Soviet central Asia and Kazakhstan. But the sea, once comparable to one of the larger Great Lakes in North America, has been shrinking at an alarming rate over the last thirty years. Anthropogenic descriffication is occurring in this region; the sea is drying up as a consequence of the development of irrigated agriculture in the basin. Its river deltas and other natural habitats, the local climate, and the regional hydrology have all been similarly affected. Moreover, these negative ecological changes have been accompanied by grave socioeconomic costs: deteriorating human health, increasing unemployment as resource based economic activity declines, and decreasing production of cotton, rice and other agricultural crops. An irre-

## Data Acquisition—Group 7B

versible ecological catastrophe is fast approaching. Saving the Aral region will require a new attitude and an entirely new approach to economic activity throughout Soviet central Asia. (Author's abstract) W91-11441

GEOMORPHIC, GEOGRAPHIC, AND HYDROGRAPHIC BASIS FOR RESOLVING THE MONO LAKE CONTROVERSY.

Lamont-Doherty Geological Observatory, Pali-

sades, NY.

S. Stine

Environmental Geology and Water Sciences EGWSEI, Vol. 17, No. 2, p 67-83, March/April 1991. 12 fig, 1 tab, 20 ref.

Descriptors: \*California, \*Closed lakes, \*Diversion, \*Lake management, \*Mono Lake, \*Saline lakes, \*Water level, Ecological effects, Erosion, Islands, Lacustrine environment, Land use.

Mono Lake, a large, hypersaline water body is situated in the lee of California's Sierra Nevada. situated in the lee of California's Sierra Nevada. Since 1940, when the Los Angeles Department of Water and Power began to divert the tributary streams that feed Mono Lake, the lake surface has dropped 45 feet, lake volume has been halved, and lake salinity has doubled. Dust storms resulting from deflation of newly exposed playa surfaces have increased in intensity, and the spatial dimensions of lacustrine habitats have been reduced. Elands used by nesting sulls have become peninsultands used to the storm of the storm o Islands used by nesting gulls have become peninsuissands used by nesting guits nave become pennisu-las, permitting coyotes to invade and disrupt the rookeries. The relationship between lake behavior and the environmental variables that lie at the center of the controversy are quantified. Resolution of the Mono Lake controversy must take into account the fact that the lake will continue to fluctuate in the future. It is unrealistic to hope that environmental change associated with future lake transgressions can be avoided simply by diverting water southward. Future rises are unavoidable. If water southward. Future rises are unavoidable. If the goal of management is to prevent the lake surface from reaching some critical level, it is necessary to 'poad' that level with a buffer that takes into account the inevitable drawdown that will occur during times of drought. Even under the most controlled conditions, in the future the lake will occupy an elevation interval rather than simply a level. Resolution of the Mono Lake prediction that the surface and the simple assessments. simply a level. Resolution of the Mono Lake pre-dicament must be based not on simple assessments of single lake levels. Rather, land managers must weigh and balance multiple environmental benefits and detriments over ranges of elevations and make decisions that involve sacrificing some resources in order to preserve others. (Author's abstract) W91-11442

MICROZOOBENTHOS OF THE RIVER JIH-LAVA AFTER THE CONSTRUCTION OF THE DALESICE WATERWORKS.

MALESIAE WALERWORKS, Brno Univ. (Czechoslovakia). Dept. of Biology. V. Opravilova. Limnologica LMNOA8, Vol. 21, No. 1, p 243-250, October 1990. 5 fig. 5 tab, 17 ref.

Descriptors: \*Benthic flora, \*Dam effects, \*Ecological effects, \*Jihlava River, \*Limnology, \*Stream biota, Algae, Biomass, Czechoslovakia, Detritus, Invertebrates, Nematodes, Periphytion, Population dynamics, Protozoa, Reservoirs, Rotifers, Species diversity, Submerged aquatic plants, Water level, Water resources development.

To ascertain the impact of the Dalesice Water-works, changes in microzoobenthos were followed at the Hrubsice station on the Jihlava River, Czechoślovakia. Microzoobenthos were studied in 4 microhabitats: epilithic algal periphyton in the torrentile stretch; detritus on submerged macrovegetation in the torrentile stretch; epilithic algal periphyton near the bank in the fluviatile stretch; and, detritus on macrovegetation near the bank in the fluviatile stretch. Microzoobenthos consisted mainly of the following groups of animals: Rhizo-poda, Ciliophora, Nematoda, Rotatoria, and Tardigrada. Abundance and biomass were studied, with biomass calculated from a volume of 0.1 mL of the sample sediment. Indices of diversity (H') and equitability (E) were also determined. In the last year of research (1985), after the waterworks had been in operation for several years, the following changes in the composition of the macrozoobenthos were found by comparison with the preconstruction situation (1976-1977): the number of construction situation (1976-1977): the number of taxa decreased somewhat (Rhizopoda, Ciliophora, Rotatoria); representation of Metazoa was lower (particularly in Rotatoria); and, the values of the indices of diversity and equitability decreased for all of the microhabitats. It was concluded that the all of the microhabitats. It was concluded that the reservoirs affected the microzoobenthos mainly by a reduction in the supply of detritus, and by deepening the river (effectively raising the water level). The character of the river at the station, which was originally that of the barbel zone, changed to that of the grayling zone. (Author's abstract) W91-11521

UPSTREAM EXTIRPATION OF FOUR MINNOW SPECIES DUE TO DAMMING OF A PRAIRIE STREAM.

PRAIRE STREAM.

Oklahoma Univ., Norman. Dept. of Zoology.

M. R. Winston, C. M. Taylor, and J. Pigg.

Transactions of the American Fisheries Society

TAFSAI, Vol. 120, No. 1, p 98-105, January 1991.

1 fig. 3 tab, 20 ref. Oklahoma Dept. of Wildlife

Conservation Project F-48-R.

Descriptors: \*Dam effects, \*Fish populations, \*Minnows, \*Prairies, \*Red River, \*Stream biota, Aquatic habitats, Chubs, Drainage area, Oklahoma, Reservoirs, Shiner, Surveys.

A spatially intensive survey in 1989 of 52 sites in the Red River drainage in southwest Oklahoma and surveys in all years from 1978 to 1987 on four sites in the drainage provided evidence that construction of Altus Dam on the North Fork of the Red River caused major changes in fish communi-ty structure in the river above the dam. Pre-im-poundment data on the fish communities were scanty, but the inferences they allowed were similar to those obtained by comparing fish assem-blages in the North Fork above the dam with assemblages elsewhere in the drainage, particularly along Salt Fork, which had similar habitat characalong Salt Fork, which had similar habitat charac-teristics. Twenty-five species were collected in the North Fork above Altus Dam, compared to 33 in the Salt Fork and 34 in the North Fork below the dam. The speckled chub Macrhybopsis aestivalis and the chub shiner Notropis potteri were absent in the North Fork above the dam but fairly common in similar streams elsewhere in the area.
The plains minnow Hybognathus placitus and the Red River shiner N. bairdi were among the most common fish species found in southwest Oklahocommon usar species found in southwest Oklaho-ma, but were not collected above Altus dam in the 1989 survey and were collected only intermittently and in small numbers in the long-term survey. It is speculated that these 2 species have repeatedly been extirpated and reestablished as bait-bucket introductions since the dam was closed. Upstream of the reservoir, the sand shiner N. stramineus and the emerald shiner N. atherinoides replaced the plains minnow and Red River shiner as dominant species. (Author's abstract) W91-11535

STRATEGIC ISSUES IN WATERSHED DEVEL-

OPMENT.
International Bank for Reconstruction and Development, Washington, DC. Environmental Policy Research Div.

For primary bibliographic entry see Field 4D. W91-11564

## 7. RESOURCES DATA

## 7A. Network Design

UTILITY OF MULTIPLE-COMPLETION MONITORING WELLS FOR DESCRIBING A SOLVENT PLUME.

Oak Ridge National Lab., TN. Environmental Sciences Div.

N. E. Korte, and P. M. Kearl. Ground Water Monitoring Review GWMRDU, Vol. 11, No. 2, p 153-156, Spring 1991. 4 fig, 1 tab,

Descriptors: \*Data acquisition, \*Groundwater pollution, \*Monitoring wells, \*Network design, \*Path of pollutants, \*Plumes, \*Solvents, Bentonite, Flow pattern, Hydraulic gradient, Sealants, Well data.

At a study site in the midwestern United States, At a study site in the midwestern United States, multiple-completion wells demonstrated that a vertical hydraulic gradient was responsible for the contamination pattern exhibited by chlorinated solvent plumes. The typical pattern consisted of little or no contamination in the upper portion of the aquifer with concentrations increasing with depth. When groundwater contamination was discovered in an unexpected portion of the site, water level elevations and contaminant distribution data obelevations and contaminant distribution data ob-tained from multiple-completion wells resulted in identification of the source location. The well eventually determined to be located in the source area displayed contaminant levels much higher in the upper zone of the aquifer-the opposite con-tamination pattern of other on-site wells. These results indicated that the spill had occurred near this locative and that solvent recitizes also a solvent. this location and that solvent residing along the capillary fringe was continuing to contaminate the aquifer. (Author's abstract) w91-10800

HYDROMETRIC DATA COLLECTION AND INTERPRETATION IN THE PRAIRIE PROVINCES AND NORTHWEST TERRITORIES. Environment Canada, Ottawa (Ontario). Water

Environment Canada, Ortawa (Ontano). Water Resources Branch. A. R. Perks, I. S. McLaurin, K. D. Harvey, J. H. Wedel, and B. N. Johnson. Canadian Journal of Civil Engineering CJCEB8, Vol. 18, No. 1, p 58-66, February 1991. 6 fig, 4 tab,

Descriptors: \*Canada, \*Data acquisition, \*Data in-terpretation, \*Network design, \*Stream gaging, Northwest Territories, Prairie Provinces, Runoff, Sediment sampler, Semiarid lands, Surface water data, Water yield.

In the Western and Northern regions of Canada, which covers more than half of the total land area of the country, streamflow and water level data are needed for many essential purposes, often in real time. The needs largely reflect the semi-arid environment and include irrigation, water supply, agricultural drought monitoring and forecasting, water apportionment, water allocation, flood fore-casting and control, hydroelectric power genera-tion, navigation, drainage, and fisheries. A hydro-metric network has been developed, with stations on both regulated and natural streams and coveron both regulated and natural streams and cover-ing large and small drainage basins. There are currently 1485 active streamflow and lake level stations in the region. Data from 1317 discontinued stations are stored in archives. At 106 sites, two-thirds of which are in Alberta, sediment data are thirds of which are in Alberta, sediment data are collected. Sediment data from another 300 discontinued sites are available. The Western and Northern Region includes six of Canada's eight major physiographic regions and three major climatic zones. Accordingly the hydrology of the region varies considerably. The hydrometric data records are the primary indicator of the state (available). varies considerably. The hydrometric data records serve as the primary indicator of the state (availability, distribution, and circulation) of surface water resources in the region at any point in time. The average annual flow is useful in assessing the surface water yield of a basin for water supply, irrigation, and environmental studies. Peak streamflows are used extensively in drainage and flood control activities. Plans for future improvements in the hydrometric network include: better documentation summarized information, and mapping of the hydrometric network include: better documen-tation, summarized information, and mapping of hydrometric stations; screening and assessment of individual station records; regional assessments to examine the representativeness of unregulated sta-tions and provide useful information for users; identification of base requirements for regional hy-drology; and enhanced data and information for general applications. (Rochester-PTT) W91-11278

## 7B. Data Acquisition

MEASUREMENT OF THE EFFECT OF ORGANIC POLLUTION ON MARINE ORGA-

#### Field 7—RESOURCES DATA

## **Group 7B—Data Acquisition**

NISMS: RAPID DETERMINATION OF EROD INDUCTION USING PLATE READERS.

Institut Français de Recherche pour l'Exploitation de la Mer, Nantes. Lab. Effets Biologiques des Nuisances.

For primary bibliographic entry see Field 5A W91-10469

STATISTICAL ANALYSIS OF ERRORS IN ES-TIMATING WET DEPOSITION USING FIVE SURFACE ESTIMATION ALGORITHMS.

Pennsylvania State Univ., University Park. Envi-ronmental Resources Research Inst. J. W. Grimm, and J. A. Lynch.

Atmospheric Environment ATENBP, Vol. 25A, No. 2, p 317-327, 1991. 6 fig. 3 tab, 18 ref. Pennsyl-vania Department of Environmental Resources co-operative Agreements ME81163 and ME86164.

Descriptors: "Acid rain, "Error analysis, "Kriging, "Monitoring, "Nitrates, "Pennsylvania, "Statistical analysis, "Sulfates, Algorithms, Chemistry of precipitation, Hydrogen ion concentration, Mathematical Processing of the Proc

Wet deposition measurements of H(+), SO2(2-) and NO3(-) from 29 monitoring sites located in and around Pennsylvania, were analyzed to quantify errors associated with extrapolating point estimates of deposition using five surface-fitting algorithms. The influence of site density on estimation errors received with seah surface agreement were also associated with each surfacing algorithm was also investigated. The five surfacing algorithms differed little in their abilities to predict the concentration or deposition of individual ions found in precipitation in Pennsylvania. However, the size of estima-tion errors for all parameters, even those based on the densest network, were quite high relative to the variation observed among monitoring sites in Pennsylvania. All monitoring site observations were within 22.8% of the median concentration for H(+), 17.6% for NO3(-), and 23.1% for SO4(2-) and within 33.9% of the median deposition for H(+), 35.3% for NO3(-), and 36.7% for SO4(2-). Maximum percent errors indicate that estimation errors may severely obscure actual surface features in at least some portions of the estimated concentration and deposition grids in Pennsylvania. Deposition and concentration estimates based on higher density networks were generally more ac-curate; however, the improvements afforded by the additional sites were quite modest. Based on the magnitude of estimation errors, kriging pro-duced the most accurate estimates, although no single algorithm consistently yielded the most ac-curate estimates for all parameters. (Author's abstract) W91-10474

RELATIONSHIP BETWEEN MEAN AND STANDARD DEVIATION IN PRECIPITATION CHEMISTRY MEASUREMENTS EASTERN NORTH AMERICA.

Atmospheric Environment Service, Downsview (Ontario).

For primary bibliographic entry see Field 2B. W91-10475

PROPERTIES OF LINEAR PROGRAMMING MODELS FOR ACID RAIN ABATEMENT. Meteorologischer Dienst der DDR, Potsdam. For primary bibliographic entry see Field 5G.

ESCCP CLOUD DATA PRODUCTS. National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies. For primary bibliographic entry see Field 2B. W91-10479

COMPARISON OF MICROWAVE TECHNIQUES FOR MEASURING RAINFALL. Applied Research Corp., Landover, MD. For primary bibliographic entry see Field 2B. W91-10499

OBSERVATION OF THE LIQUID WATER CONTENT OF MELTING SNOWFLAKES WITH A NEW INSTRUMENT.

For primary bibliographic entry see Field 2C. W91-10516

ENVIRONMENTAL INFORMATION PROC-ESSING OF CLOSED BAY AREA BY REMOTE SENSING. Tokushima Univ. (Japan). Dept. of Information

Tokushina Ontv. (Japan). Dept. of Information Science and Intelligent Systems. S. Omatu, T. Soeda, and K. Kitamura. Marine Pollution Bulletin MPNBAZ, Vol. 23, p 551-555, 1991. 4 fig, 4 tab, 4 ref.

Descriptors: \*Coastal waters, \*Environmental monitoring, \*Mathematical models, \*Model studies, \*Remote sensing, \*Satellite technology, \*Water quality monitoring, Calibrations, Chlorophyll a, Comparison studies, Statistical methods, Suspended sediments, Transparency, Water tem-

To maintain a high quality of the environment in a closed bay area, the water quality must be monitored at closely located points. Due to limited availability of measurement devices, obtaining all necessary measurements is often difficult. Remote sensing techniques may solve this problem. Remote sensing data were obtained by multi-spectral scanner for three years in the summer from tral scanner for three years in the summer from 1980 to 1982. Applying regression analysis to the remote sensing data and sea truth data, distribution maps can be obtained for water temperature, transparency, chlorophyll a, and suspended sediments. A correction model was developed to provide statistical data correction, using quadratic equations. To correct for MSS distortion of the data, the three components (reflectance, radiant flux from sunlight, and radiant flux scattered from the terrain), are used from the statistical and physical trom suninght, and radiant flux scattered from the terrain), are used from the statistical and physical viewpoints. The results from the physical model conformed to that of the statistical model. Thus, since each method can be used independently to delete the pass radiance, this method is more flexible than the physical modelling method since the correction pagemeters can be estimated by using correction parameters can be estimated by using the observed MSS data. The statistical method cannot offer any physical meaning even though the physical modeling method gives concrete meaning to the parameters and the correction method. The problem that remains to be solved is applying the method to correct the shadow area produced by clouds (Brunone-PTT)

FLOW CONTROL TECHNOLOGY FOR EN-HANCEMENT AND DIVERSE USE OF THE MARINE ENVIRONMENT.

Government Industrial Research Inst., Chugoku, For primary bibliographic entry see Field 2L. W91-10607 Kure (Japan).

BIODEGRADABLE DISSOLVED ORGANIC CARBON (BDOC) CONTENT OF DRINKING WATER AND POTENTIAL REGROWTH OF

BACTERIA.
Centre de Recherche de Maisons-Laffitte (France).
For primary bibliographic entry see Field 5F.
W91-10630

F-SPECIFIC RNA BACTERIOPHAGES AS MODEL VIRUSES IN UV DISINFECTION OF WASTEWATER.

Rijksinstituut voor de Volksgezondheid, Bilthoven (Netherlands). Lab. for Water and Food Microbi-

For primary bibliographic entry see Field 5D. W91-10682

CLOSTRIDIUM PERFRINGENS, AS AN INDI-CATOR MICROORGANISM FOR THE EVAL-UATION OF THE EFFECT OF WASTEWATER AND SLUDGE TREATMENT SYSTEMS.

Azabu Univ., Sagamihara (Japan). Dept. of Environmental Technology.

For primary bibliographic entry see Field 5D.

W91-10686

SALMONELLA DETECTION IN SEWAGE WATERS USING FLUORESCENT ANTI-BODIES.

Rennes-1 Univ. (France). Lab. de Microbiologie Pharmaceutique For primary bibliographic entry see Field 5D. W91-10687

INSTALLATION OF THE WESTBAY MULTI-PORT GROUND-WATER SAMPLING SYSTEM IN WELL 699-43-42K NEAR THE 216-B-3

Battelle Pacific Northwest Labs., Richland, WA. T. J. Gilmore.

Available from the National Technical Information Service, Springfield, VA 22161, as DE90-001006. Price codes: A03 in paper copy, A01 in microfiche. Report No. PNL-6973, September 1989. 28p, 8 fig, 4 ref, append.

Descriptors: \*Groundwater quality, \*Hanford, \*Monitoring wells, \*Path of pollutants, \*Sampling, \*Washington, \*Well construction, Aquifers, Backfilling, Geohydrology, Groundwater pollution,

In 1988 and 1989, Pacific Northwest Laboratory installed a multiport groundwater sampling system in well 699-43-42K drilled near the 216-B-3 Pond on the Hanford Site in southeastern Washington State. The multiport system will be used to evaluate methods for determining the vertical distribu-tion of contaminants and hydraulic heads in groundwater. The installation was in conjunction with a similar multiport installation near the 300 Area of the Hanford Site. Well 699-43-42K is Area of the manord site. Well 693-43-42A is adjacent to two Resource Conservation and Recovery Act (RCRA) groundwater monitoring wells, which will allow for a comparison of sampling intervals and head measurements between the philig intervals and heat measurements of everet the multiport system and the RCRA monitoring wells. Eight sampling ports were installed in the upper unconfined aquifer by backfilling at depths of 161. If, 174.1 ft, 187.1 ft, 201.17 ft, 217.2 ft, 230.2 ft, 243.2 ft, and 255.2 ft below land surface. However, 243.2 ft, and 255.2 ft below land surface. However, because of damage to the casing during installation, only the top four ports could be used for pressure measurements and sampling until repairs are made. The locations of the sampling ports were determined by the geohydrology of the area and the screened intervals of adjacent groundwater monitoring wells. Installation by backfilling around the multiport system was the first method of its kind on the Hanford Site and proved adequate. For future installations, an alternative method was recommended. amu on the stantord Site and proved adequate. For future installations, an alternative method was recommended, whereby the multiport system would be placed inside a cased and screened well using packers to isolate the sampling zones. (Lantz-PTT) W91-10720

ZONAL AVERAGE CLOUD CHARACTERISTICS FOR GLOBAL ATMOSPHERIC CHEMISTICS FOR GLOBAL ATMOSPHERIC FOR GLOBAL ATMOSPHERIC

Max-Planck-Inst. fuer Chemie, Mainz (Germany,

For primary bibliographic entry see Field 2B. W91-10728

ARCHIMEDES IIA EXPERIMENT ON OIL SLICK DETECTION OVER THE NORTH SEA-APRIL 1988-MEASUREMENT RESULTS OB-TAINED BY THE E-SAR SYSTEM OF THE GERMAN AEROSPACE RESEARCH ESTAB-LISHMENT.

Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Oberpfaffenhofen (Ger-many, F.R.).

For primary bibliographic entry see Field 5B. W91-10742

INVESTIGATION OF LOCAL SCOUR IN CO-HESIONLESS SEDIMENTS USING A TUNNEL-MODEL.

Waterloopkundig Lab. te Delft (Netherlands For primary bibliographic entry see Field 2J.

## Data Acquisition—Group 7B

W91-10746

PHOSPHORUS IN THE TRUCKEE RIVER BE-TWEEN VISTA AND PATRICK, STOREY AND WASHOE COUNTIES, NEVADA, AUGUST

Geological Survey, Carson City, NV. For primary bibliographic entry see Field 5A. W91-10763

DETERMINATION OF SUBNANOMOLAR LEVELS OF IRON(ID AND TOTAL DISSOLVED IRON IN SEAWATER BY FLOW INJECTION ANALYSIS WITH CHEMILUMINES-

CENCE DETECTION.

Moss Landing Marine Labs., CA.

For primary bibliographic entry see Field 2K.
W91-10773

ANALYSIS OF GROUND-PROBING RADAR DATA: PREDICTIVE DECONVOLUTION. Geological Survey of Canada, Ottawa (Ontario). Terrain Sciences Div. For primary bibliographic entry see Field 8G.

DETERMINATION OF EFFECTIVE DIFFU-DETERMINATION OF EFFECTIVE DIFFU-SION COEFFICIENTS FOR GASEOUS AND DISSOLVED ORGANIC SUBSTANCES IN SOIL MATERIAL USING A "STOPPED ELUTION" METHOD WITH HPLC AND GC. Bayreuth Univ. (Germany, F.R.). Chair of Ecolog-ical Chemistry and Geochemistry. K. U. Goss, and K. W. Schramm. Journal of Soil Science ISSCAH, Vol. 42, No. 1, p 47-58, March 1991. 2 fig, 5 tab, 31 ref.

Descriptors: \*Diffusion, \*Diffusion coefficient, \*Gas chromatography, \*Path of pollutants, Adsorption, Algorithms, Data acquisition, Experimental data, Experimental design, Ficks Law, High performance liquid chromatography, Laboratory methods, Leaching, Mathematical analysis, Mathematical equations, Saturated soils, Soil analysis,

Non-steady-state diffusion of chemicals in soil can be described by Fick's second law using suitable effective diffusion coefficients. A 'stopped elution' method was developed to experimentally deter-mine these effective diffusion coefficients for gasemine these effective diffusion coefficients for gase-ous and dissolved substances in dry and water saturated soil. For this purpose a high-performance liquid chromatograph (HPLC) apparatus and a gas chromatograph (SS) were used in combination with soil-filled columns. The method is based on the observed spreading of a substance moving through a soil column, a result of several processes, one of which is diffusion. A suitable experimenes, one of which is diffusion. A suitable experimental design permits the separate measurement of that part of the widening caused by diffusion. The measured effective diffusion coefficients were compared with theoretical values calculated using predictive algorithms from the literature. For liquid-phase diffusion, the maximum deviation between the calculated and the measured values was 34%. The experimental results for gaseous diffusion showed systematic upward deviation from the calculated coefficients. This might be caused by the diffusion of molecules in the adsorbed state, a phenomenon that had been neglected in the calculations. (Author's abstract)

SIMPLE DESIGN FOR SIMULTANEOUS STEADY-STATE INFILTRATION EXPERI-MENTS WITH RING INFILTROMETERS California Univ., Berkeley. Dept. of Soil Science. Water Resources Bulletin WARBAQ, Vol. 26, No. 6, p 935-938, December 1990. 4 fig, 6 ref.

Descriptors: \*Experimental design, \*Infiltration, \*Infiltrometers, \*Measuring instruments, \*Soil water, Analytical methods, Data collections, water, Analytical methods, Data collections, Design criteria, Experimental data, Model studies, Oklahoma, Rainfall-runoff relationships, Ring infiltrometers, Spatial variability, Steady-state infiltration, Watersheds.

A methodology has been developed to characterize the spatial variability of infiltration across a catchment. The methods used involved the collection of a large new set of steady-state infiltration data, without redundancy, for a small rangeland catchment located northeast of Chickasha, Oklahoma. The new data set will then be used as input to a quasi-physically based model for simulations of rangellatrange events. Simplicity of the infiltration a quasi-physically based model for simulations of rainfall-runoff events. Simplicity of the infiltration experiments, and therefore the equipment, was of the utmost importance. To fulfil these criteria, the cylinder-type or flooding-type infiltrometer was selected. A large-diameter, single ring infiltrometer, capable of providing the best measure of true vertical infiltration was assumed. A total of 247 steady-state infiltration measurements were made across the rangeland catchingth using the new across the rangeland catchment using the new methodology. The procedure for measuring steady-state infiltration rates in remote locations steady-state infiltration rates in remote locations was quite successful. The equipment proved to be of a simple design, inexpensive, and rugged. One person could easily manage several installations and coordinate the staggered experiments. The large diameter of the rings facilitated relatively undisturbed surface measurements that minimized boundary and small-scale effects. The limiting factor for the multiple-ring system was that it required large quantities of water. (Korn-PTT) W91-10813

SPECTROPHOTOMETRIC DETERMINATION OF NITRITE IN POLLUTED WATERS USING

3-NITROANILINE, Aligarh Muslim Univ. (India). Chemistry Section. For primary bibliographic entry see Field 5A. W91-10823

SIMULTANEOUS ULTRAVIOLET SPECTRO-PHOTOMETRIC DETERMINATION OF NI-TRATE AND NITRITE IN WATER.

Department of Polymer Chemical Engineering, Liaoyang Petrochemical College, Liaoyang, China For primary bibliographic entry see Field 5A. W91-10824

RAPID PRECONCENTRATION METHOD FOR MULTIELEMENT ANALYSIS OF NATURAL FRESHWATERS.

RESTWALERS. Stockholm Univ. (Sweden). Dept. of Geology. P. Andersson, and J. Ingri. Water Research WATRAG, Vol. 25, No. 5, p 617-620, May 1991. 2 fig. 4 tab, 9 ref.

Descriptors: \*Analytical methods, \*Chemical analysis, \*Detection limits, \*Emission spectrometry, \*Metals, \*Preconcentration, \*Sample preparation, \*Water analysis, Aluminum, Beryllium, Cadmium, Chromium, Cobalt, Copper, Iron, Manganese, Nickel, Scandium, Vanadium, Ytterbium, Yttrium,

An inexpensive and rapid preconcentration method was developed which can be applied directly in the field. It is based on coprecipitation with magnesism hydroxide and was applied for Al, Fe, Mn, Zn, Cu, Ni, V, Cr, Co, Be, Y, Sc, and Yb in freshwaters. The method was tested using inductively coupled plasma-atomic emission spectroscopy (ICP-AES) by adding known amounts of metals to distilled water and natural freshwater. The detection distilled water and natural freshwater. The detection limit for ICP-AES can be enhanced more than two orders of magnitude for Al, Y, Sc, and Yb and approximately one order of magnitude for the other tested elements. (Author's abstract)

CHROMATOGRAPHIC SEPARATION OF AR-SENIC SPECIES WITH SODIUM BISCIRIFLUOROETHYL)DITHIOCARBAMATE CHELATION.

Idaho Univ., Moscow. Dept. of Chemistry. For primary bibliographic entry see Field 5A. W91-10894

SENSITIVE HIGH-PERFORMANCE LIQUID CHROMATOGRAPHIC ANALYSIS FOR TOXI-COLOGICAL STUDIES WITH CARBARYL.

Virginia-Maryland Regional Coll. of Veterinary Medicine, Blacksburg, VA. Dept. of Biomedical Sciences. For primary bibliographic entry see Field 5A. W91-10920

DEVELOPMENT OF AN ENZYME-LINKED IMMUNOSORBENT ASSAY FOR GEOSMIN. Southern Regional Research Lab., New Orleans,

For primary bibliographic entry see Field 5F. W91-10921

APPLICATION OF GROUND-PENETRATING-RADAR METHODS IN HYDROGEOLOGIC STUDIES.

Geological Survey, Hartford, CT. Water Resources Div.

M. Beres, and F. P. Haeni. Ground Water GRWAAP, Vol. 29, No. 3, p 375-386, May/June 1991. 11 fig, 2 tab, 35 ref.

Descriptors: \*Geohydrology, \*Geophysical methods, \*Ground penetrating radar, \*Radar, \*Remote sensing, Aquifer characteristics, Connecticut, Electromagnetic waves, Geophysical exploration, Geophysical surveys, Glacial sediments, Groundwater, Hydrologic data.

Ground-penetrating radar is one of the most promising surface-geophysical methods for use in hydrogeologic and surficial mapping studies. A ground-penetrating-radar system was used to study selected stratified-drift deposits in Connecticut. selected stratified-drift deposits in Connecticut. Ground-penetrating radar is a surface-geophysical method that depends on the emission, transmission, reflection, and reception of an electromagnetic pulse and can produce continuous high-resolution profiles of the subsurface rapidly and efficiently. Traverse locations on land included a well field in the town of Mansfield, a sand and gravel pit and a farm overlying a potential aquifer in the town of Coventry, and Haddam Meadows State Park in the town of Haddam. Traverse locations on water included the Willimantic River in Coventry, and Mansfield Hollow Lake in Mansfield. The penetration depth of the radar signal ranged from about 20 feet in fine-grained glaciolacustrine sediments to about 70 feet in coarse sand and gravel. Some land about 70 feet in coarse sand and gravel. Some land about 5 to 11 feet below land surface. Parallel about 5 to 11 feet below and surface. Faranier reflectors on the records are interpreted as fine-grained sediments. Hummocky or chaotic reflectors are interpreted as cross-bedded or coarse-grained sediments. Other features observed on some of the radar records include the till and ce. Records collected on water had distinct water-bottom multiples (more than distinct water-bottom multiples (more than one reflection) and diffraction patterns from boulders. The interpretation of the radar records, which required little or no processing, was verified by using lithologic logs from test holes located along some of the land traverses and near the water traverses. (Author's abstract)
W91-10956

DELINEATION OF TRAVELTIME-RELATED CAPTURE AREAS OF WELLS USING ANALYTICAL FLOW MODELS AND PARTICLE-TRACKING ANALYSIS.

Ohio State Univ., Columbus. Dept. of Geology and Mineralogy. For primary bibliographic entry see Field 2F. W91-10957

ACOUSTIC PARAMETRIC ARRAY FOR MEASURING THE THICKNESS AND STRATIGRAPHY OF CONTAMINATED SEDI-

MENTS.
Memorial Univ. of Newfoundland, St. John's.
Centre for Cold Ocean Resources Engineering.
For primary bibliographic entry see Field 2J.
W91-10981

CHANGES WITH TIME OF THE TRANSPORT RATE OF SEDIMENT MIXTURES

#### Field 7—RESOURCES DATA

## **Group 7B—Data Acquisition**

Aberdeen Univ. (Scotland). Dept. of Engineering. R. I. Hardwick, and B. B. Willetts. Journal of Hydraulic Research JHYRAF, Vol. 29, No. 1, p 117-127, 1991. 9 fig, 2 tab, 11 ref.

Descriptors: \*Bed load, \*Sediment sampler, \*Sediment sampling, \*Sediment transport, \*Sediments, Bed-load discharge, Channel armoring, Flumes, Particle size, Trap efficiency.

A novel sediment trap, designed to enable bed-load activity to be related to elapsed time, has been developed. The trap body provides an envelope for the collection of material which is 8 mm x 50 mm x 384 mm, and has a receptacle to accommodate material inadvertently entering the trap during the preparation of the bed at the bottom of this prismatic collector volume. Its two particularly important features are (1) it is transparent, so the accumulation of trapped material can be seen and iy) important reatures are (1) it is transparent, so the accumulation of trapped material can be seen, and (2) the front of the trap is detachable so that samples can be obtained from identifiable intervals during experimentation. The trap was used in a abort pilot experimentation. The trap was used in a short pilot experiment on the armoring of a mixed grain size bed in a small laboratory flume. Despite the limitations of the experiment, significant infor-mation was obtained about the variation with time of bed load transport rate and of the composition of the bed load in the early stages of armoring. The changes of composition were represented in terms of log hyperbolic size distributions. There was confirmation that the transport rate of grain mixcommunation that the transport rate of grain mix-tures is a function not only of flow and grain parameters, but also of time. It was concluded that, for the purpose of validating numerical models of the armoring process, information about bed load composition has higher value than data on changes in the static bed population, because the latter involve severe sampling problems. Thus the trap provides new opportunities in the development of kmowledge about bed winnowing and armoring.

MICROWAVE TRANSMISSION, A NEW TOOL

IN FOREST HYDROLOGICAL RESEARCH.
Amsterdam Univ. (Netherlands). Lab. for Physical Geography and Soil Science.
For primary bibliographic entry see Field 2I.
W91-10995

# MULTIPARAMETER RADAR ESTIMATION OF RAINDROP SIZE DISTRIBUTION. Colorado State Univ., Fort Collins. V. N. Bringi, and V. Chandrasekar. Available from the National Technical Information

Available from the National Technical Information Service, Springfield, VA. 22161, as AD-A212 410. Price codes: A02 in paper copy, A01 in microfiche. Report No. ARU-239355-GS, September 1, 1989. Final Report (Amended). 2p, 9 ref. Army Research Office Contract No. DAAL03-86-K-0117.

Descriptors: \*Particle size, \*Radar, \*Rain, \*Remote sensing, \*Simulation analysis, Distribution analysis, Rainfall, Reflectivity, Statistical anal-

The error structure of multiparameter radar and surface disdrometer measurements of rainfall has been studied in detail. The radar observable stud-ied were reflectivity, differential reflectivity and X-band specific attenuation. These radar observable were simulated from fundamental considerations which incorporated statistical fluctuations ations which incorporated statistical fluctuations due to the Doppler spectrum and the cross-correlation between H and V-polarized signals at zero time lag. Additionally, natural variations in the raindrop size distribution were incorporated into the simulations by assuming a gamma form for the size distribution. Thus, the radar simulations contain the effects of both statistical fluctuations and physical variations. The simulation results produce realistic scatter as observed with data acquired by the NCAR CP-2 radar. (Author's abstract)

EVALUATION OF THREE SCENARIOS OF GROUND-WATER WITHDRAWAL FROM THE MISSISSIPPI RIVER ALLUVIAL AQUIFER IN

Geological Survey, Jackson, MS. Water Resources

For primary bibliographic entry see Field 4B.

S. GEOLOGICAL SURVEY FEDERAL-STATE COOPERATIVE WATER-RESOURCES PRO-GRAM FISCAL YEAR 1989. Geological Survey, Reston, VA. Water Resources

B. K. Gilbert, and W. B. Mann Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 90-353, 1990. 49p, 2 fig, 6

Descriptors: \*Cooperative Water Resources Program, \*Data acquisition, \*Data interpretation, \*Water resources institutes, Economic aspects, Financial aspects, Groundwater quality, Information Water resources data

The Federal-State Cooperative Program is a major U.S. Geological Survey (USGS) activity for the collection, analysis, and reporting of information on the quantity and quality of the Nation's water resources. The fundamental characteristic of the program is that most of the work is undertaken by the USGS through partnership agreements (50:50 matching of funds) with State, regional, and local agencies. The program's main objectives are to: (1) agencies. Ine program's main objectives are to: (1) collect, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources, and (2) analyze the data for the purpose of appraising the availability and the physical, chemical, and biological characteristics of surface and groundwater. During fiscal year 1989, hydrolegic data collection, interestrict investigation. logic data collection, interpretive investigations, and research under the provisions of the Cooperative Program were conducted by Geological Survey personnel in offices in every State, Puerto Rico, and several territories in concert with more than 1,000 cooperating agencies. In fiscal year 1989, Federal funding of almost \$59 million was matched by cooperating agencies, who also provided approximately \$8 million unmatched for a total program of about \$126 million. This amounted to more than 40% of the total funds for the Geological Survey's water resources activities. This report presents examples of current (1989) investigations, as well as updated information on the National Water Use Information Program, hydrologic investigations and research related to agriculture, and projects selected and funded under the merit proposal system. (Author's abstract) W91-11109

METHODOLOGY TO DERIVE WATER-QUALITY TRENDS FOR USE BY THE NATIONAL WATER SUMMARY PROGRAM OF THE U.S. GEOLOGICAL SURVEY.

Geological Survey, Reston, VA. Water Resources

K. J. Lanfear, and R. B. Alexander. Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 90-359, 1990. 10p, 2 fig, 2

Descriptors: \*Data acquisition, \*Data collections, \*Data interpretation, \*Data storage and retrieval, \*Water quality, Automation, Statistical analysis, Statistical methods.

Methods were developed to examine a water quality record and, based on the application of a detailed set of trend testing criteria, determine whether a monthly, bimonthly, or quarterly test for monotonic trend could be performed. The trend testing criteria were automated and allowed for an efficient and accurate analysis for trend in an extremely large number of water quality records.
Water quality records for about 3,000 stations and into the discount of the state of t were evaluated as to their suitability for trend testing. From this set of records, it was determined that about 1,100 stations had at least one water quality constituent that met the criteria for trend testing. For those water quality records, a nonpar-

ametric test for monotonic trend, known as the seasonal Kendall test, was applied to three time periods (1970-89, 1975-89, and 1980-89). (Author's W91-11110

AUTOMATIC TRACER-DILUTION METHOD USED FOR STAGE-DISCHARGE RATINGS AND STREAMFLOW HYDROGRAPHS ON SMALL IOWA STREAMS.

Geological Survey, Iowa City, IA. Water Resources Div. P. J. Soenksen.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 89-4187, 1990. 45p, 26 fig, 1 tab, 14 ref, append.

\*Automation. \*Data acquisition. Descriptors: Descriptors: "Automation, "Data acquisition," Gages, 'Hydrographs, \*Instrumentation, 'Measuring instruments, 'Stage-discharge relations, 'Stream gaging, 'Streamflow, \*Tracers, Evaluation, Flow velocity, Iowa, Rhodamine-WT, Stream discharge.

An automatic system was designed to concurrently measure stage and discharge for the purpose of developing stage-discharge ratings and high flow hydrographs on small streams. Stage, or gage height, is recorded by an analog-to-digital recorder and discharge is determined by the constant-rate tracer-dilution method. The system measures flow above a base stage set by the user. To test the effectiveness of the system and its components, eight systems, with a variety of equipment, were installed at crest-stage gaging stations across lowa. A fluorescent dye, rhodamine-WT, was used as the tracer. Tracer-dilution discharge measurements were made during 14 flow periods at six stations from 1986 through 1988 water years. Ratings were developed at three stations with the aid of these measurements. The most serious problem seems to have been the unequal splitting of flow from a single-head pump for multiple-point injection of single-head pump for multiple-point injection of the dye. A redesign of the splitter, or some other part of the injection line, is needed. Samplers need to be checked and serviced routinely, whether they have been activated or not. Many samples were never collected because of sampler malfunc-tion. An in-line filter system would have reduced tion. An in-line filter system would have reduced or eliminated dye losses to sediment. The possible locations of a pressurized filter in the Manning sampler were limited, and the problem has not been solved. Until some type of filter is developed, it is important to service the automatic tracer dilution stations promptly after a flood, decant only clear water and engine the semple; in a reasonaclear water, and analyze the samples in a reasona-ble amount of time. After a flow, it is important to always service the sampler before servicing the dye injection site. (Lantz-PTT) W91-11111

COMMUNICATING WITH FARMERS: PRO-VIDING USEFUL AND RELIABLE SOURCES OF INFORMATION.

For primary bibliographic entry see Field 5G. W91-11164

EMERGING ISSUES AT THE INTERSECTION OF AGRICULTURAL AND ENVIRONMENTAL POLICY.

For primary bibliographic entry see Field 5G. W91-11165

MINNESOTA DISTRICT, WATER RE-SOURCES DIVISION: INFORMATION AND TECHNICAL ASSISTANCE.

For primary bibliographic entry see Field 2F.

PLANNED STUDIES OF AGRICHEMICALS IN GROUND AND SURFACE WATER IN THE MID-CONTINENTAL UNITED STATES.

Geological Survey, Reston, VA. For primary bibliographic entry see Field 5B.

# Data Acquisition—Group 7B

PESTICIDES AND DRINKING WATER INFOR-MATION: A PERSPECTIVE FROM EPA'S NA-TIONAL PESTICIDE SURVEY.

For primary bibliographic entry see Field 5D. W91-11173

CLASSIFICATION OF SNOW COVER AND PRECIPITATION USING THE SPECIAL SENSOR MICROWAVE IMAGER.

National Oceanic and Atmospheric Administration, Washington, DC. Environmental Data and Information Service.

N. C. Grody

N. C. Orody. Journal of Geophysical Research (D) Atmospheres JGRDE3, Vol. 96, No. 4, p 7423-7435, April 20, 1991. 14 fig, 2 tab, fig, 22 ref.

Descriptors: \*Classification, \*Microwaves, \*Remote sensing, \*Satellite technology, Algorithms, Atmospheric water, Data acquisition, Mathematical equations, Measuring instruments, Precipitation, Radio waves, Snow cover, Special sensor microwave imager.

Since 1972, various microwave radiometers have been flown aboard polar-orbiting satellites to meas-ure the radiation emitted from the Earth at select-ed frequencies between 6 and 85 GHz. The radidef frequencies between 6 and 85 GHz. The radiation measurements provide unique signatures for identifying surface features and obtaining the temperature and composition of the Earth's atmosphere. The special sensor microwave mager (SSMI) is a seven-channel microwave radiometer that has dual polarized channels at 19, 37, and 85 GHz and a vertically polarized channel at 22 GHz. A detailed evaluation was conducted of all SSMI channels to arrive at the optimum channel selection for global identification of precipitation and snow cover without the use of any ancillary information. The resulting algorithm takes the form of a decision tree that uses the dual polarized channels at 19 GHz and the vertically polarized channels at 22 Hz and 85 GHz. These four channels enable the identification of precipitation from all other atmosidentification of precipitation from all other atmos-pheric and surface features, including snow cover. (Author's abstract) W91-11219

NATURE OF SUSPENDED SOLIDS AND IRS1A-LISSI DATA: A CASE STUDY OF TAWA RESERVOIR (NARMADA BASIN).

Jawaharlal Nehru Univ., New Delhi (India). School of Environmental Sciences. For primary bibliographic entry see Field 5G. W91-11221

STREAM CHEMISTRY IN THE EASTERN UNITED STATES: 1. SYNOPTIC SURVEY DESIGN, ACID-BASE STATUS, AND REGION-

AL PATTERNS.
Utah Water Research Lab., Logan.
For primary bibliographic entry see Field 5B.
W91-11241

DEVELOPMENT OF AN ENZYME IMMUN-OASSAY FOR THE DETERMINATION OF METAZACHLOR.

Technische Univ. Muenchen, Freising (Germany, F.R.). Lehrstuhl fuer Botanik. For primary bibliographic entry see Field 5A. W91-11295

NOAA SATELLITE DATA IN NATURAL OIL SLICK DETECTION, OTWAY BASIN, SOUTH-ERN AUSTRALIA.

For primary bibliographic entry see Field 5A. W91-11296

PRECONCENTRATION OF HYDROPHILIC AND HYDROPHOBIC PESTICIDES FROM AQUEOUS SOLUTIONS AND EXTRACTION OF RESIDUES USING THE POLYMERIC SOR-BENT WOFATIT Y 77.

Akademie der Wissenschaften der DDR, Leipzig. Forschungsstelle fuer Chemische Toxikologie. For primary bibliographic entry see Field 5A. W91-11305

COMPARISON OF AMPEROMETRIC AND UV-SPECTROPHOTOMETRIC MONITORING IN THE HPLC ANALYSIS OF PESTICIDES, Hunan Univ., Changsha (China). Dept. of Chemistry and Chemical Engineering. For primary bibliographic entry see Field 5A. W91-11306

MULTI-RESIDUE-ANALYSIS OF PESTICIDES BY HPLC AFTER SOLID PHASE EXTRAC-TION.

Gelsenwasser A.G., Gelsenkirchen (Germany, F.R.).

For primary bibliographic entry see Field 5A. W91-11307

APPLICATION OF HPLC COLUMN-SWITCH-ING IN PESTICIDE RESIDUE ANALYSIS, Rijkinstitut voor de Volksgezondheid en Milieu-hygiene, Bilthoven (Netherlands). For primary bibliographic entry see Field 5A. W91-11308

ANALYSIS OF 10 SELECTED HERBICIDES IN WATER.

For primary bibliographic entry see Field 5A. W91-11311

SOLID-PHASE EXTRACTION FOR MULTI-RESIDUE ANALYSIS OF SOME TRIAZOLE AND PYRIMIDINE PESTICIDES IN WATER. Imperial Chemical Industries Ltd., Bracknell (Eng-For primary bibliographic entry see Field 5A.
W91-11313

COLIPHAGE AND BACTERIOPHAGE AS IN-DICATORS OF RECREATIONAL WATER

Ontario Ministry of the Environment, London. Technical Support Section.
For primary bibliographic entry see Field 5A.
W91-11334

USE OF A SINGLE-BOWL CONTINUOUS-FLOW CENTRIFUGE FOR DEWATERING SUSPENDED SEDIMENTS: EFFECT ON SEDI-MENT PHYSICAL AND CHEMICAL CHARAC-

TERISTICS.
Geological Survey, San Diego, CA.
T. F. Rees, J. A. Leenheer, and J. F. Ranville.
Hydrological Processes HYPRE3, Vol. 5, No. 2, p
201-214, April/June 1991. 6 fig, 5 tab, 27 ref.

Descriptors: \*Centrifugation, \*Dewatering, \*Laboratory methods, \*Separation techniques, \*Suspended sediments, Particle size, Physicochemical properties, Statistical analysis.

A fundamental problem associated with contaminant transport studies is the collection of enough material to achieve detection of trace contaminants. A study was undertaken to evaluate the use of a single-bowl continuous flow centrifuge (CFC) for dewatering suspended sediment from large volumes (>100 L) of river water. The Sharples Model AS-12 CFC was used as part of a major study of sediment-associated transport of contaminants in the lower Mississippi River system. Sediment-recovery efficiencies ranged between 86 and nants in the lower Mississippi River system. Sedi-ment-recovery efficiencies ranged between 86 and 91% and were comparable to that of other types of CFC units. The recovery was limited by the parti-cle-size distribution of the feed water and by the limiting particle diameter (i.e., 370 nm) that was retained in the centrifuge bowl. There appeared to be no particle-size fractionation within the centribe no particle-size fractionation within the centri-fuge bowl as the median particle size was the same at the top as at the bottom. Particle electrophoretic mobilities were typical of clays coated with organ-ic matter, the charge of which was partially neu-tralized by divalent cations and iron. Contamina-tion by trace metals and organics was minimized by coating all surfaces that came in contact with the samples with either FEP or PFA Teflon and using a removable FEP Teflon liner in the centri-fuge bowl. CFC is a potentially useful tool in investigations of contaminant transport associated

with suspended sediments. It is a rapid technique to dewater sediments collected from large volumes of surface waters. However, because of the apparof surface waters. However, occase of ine appar-ent concentration dependence on collection effi-ciency, and the calculated limiting particle diame-ter, the potential for losing substantial quantities of important suspended mass must be recognized. (Korn-PTT) W91-11350

USE OF 137CS AS A TRACER IN AN EROSION STUDY IN SOUTH LIMBURG (THE NETHERLANDS) AND THE INFLUENCE OF CHERNO-BYL FALLOUT.

Utrecht Rijksuniversiteit (Netherlands). Inst. of Geographical Research.

A. P. J. De Roo.

Hydrological Processes HYPRE3, Vol. 5, No. 2, p 215-227, April/June 1991. 6 fig, 6 tab, 43 ref.

Descriptors: \*Fallout, \*Geostatistics, \*Isotopic tracers, \*Soil erosion, \*The Netherlands, Cesium radioisotopes, Chernobyl, Isotope studies, Mapping, Model studies.

A study has been undertaken to investigate the extent to which the 137Cs content of soils can be used as a tracer to estimate soil erosion rates over the past 30 years in the Etzenrade drainage basin in the past 30 years in the Etzenrade drainage oasin in South Limburg. The Netherlands. In addition, it has been proposed that the extra fallout input of 137Cs from the Chernobyl nuclear accident in 1986 may provide new possibilities for mapping short-term soil erosion rates. Soil samples from 143 sites within the Etzenrade catchment were analyzed to map the 137Cs redistribution using geostatistical intercelation, each of the results of the results of the sentitle of the senti lyzed to map the 137Cs redistribution using geostatistical interpolation methods. The results of the study revealed that Cesium-137 activities on waning slopes were higher than activities on steep slopes. The average net erosion in the Etzenrade catchment for the last 30 years, as calculated from 137Cs data, was estimated to be 418 tons/ha. A comparison of the soil erosion estimates from the 137Cs-based data and the Universal Soil Loss Equation (USLE) erosion model revealed a negative correlation. This implies the need for more advanced models to predict soil erosion patterns. The recent Chernobyl nuclear accident also contributed to the 137Cs activity. Cesium-134 is an exclusive product of Chernobyl and has a 137Cs:134Cs ratio of 1.765:1. However, the Chernobyl input of 137Cs cannot be used as a tracer of soil erosion because of the large spatial variation of 134Cs between the reference sites. Due to the rapid decay of 134Cs, it will not be possible to rapid decay of 134Cs, it will not be possible to separate the sources of 137Cs in the near future in areas significantly influenced by Chernobyl fallout. Therefore, 137Cs can no longer be used as a soil erosion tracer in these areas. (Korn-PTT) W91-11351

LOW COST FLOW INJECTION ANALYSIS FOR CADMIUM USING 2-(2-BENZOTHIAZO-LYLAZO) -4,5-DIMETHYLPHENOL.

Chiang Mai Univ. (Thailand). Dept. of Chemistry. For primary bibliographic entry see Field 5A. W91-11379

USE OF ELECTRONIC DATA-LOGGING EQUIPMENT TO MONITOR HYDROLOGIC PARAMETERS IN A HUMID CAVE NATIONAL PARK, SOUTH DAKOTA.

E. A. Greene. The NSS Bulletin NSSBDR, p 129-131, December 1989. 3 fig, 3 ref.

Descriptors: \*Cave lakes, \*Caves, \*Electronic equipment, \*Karst hydrology, \*Logging (Recording), \*Wind Cave National Park, Air temperature, Atmospheric pressure, Data acquisition, Groundwater, Hydrologic properties, Measuring instruments, South Dakota, Water level, Water tempera-

The US Geological Survey has installed electronic data-logging equipment at Windy City Lake in Wind Cave to monitor changes in water level, water temperature, and barometric pressure. These

#### Field 7—RESOURCES DATA

# **Group 78—Data Acquisition**

parameters are being monitored in response to the concern of park managers that water levels in this area of the cave are progressively declining. Description of equipment and the methodology used to collect data in this remote area of the cave are presented. Preliminary results for the first 6 months of the study indicate that the lightweight, durable data-logging equipment works successfully in the humid cave environment. Water levels at in the numic cave environment. Water levels at Windy City Lake appear to slightly fluctuate in response to barometric pressure changes, and have declined 0.176 m from January 21, 1988, to July 18, 1988. Water temperature in Windy City Lake and temperature of the air in the cave are constant at 13.8 and 15.0 C, respectively. (Author's abstract)

EMPIRICAL METHOD OF ESTIMATING RAINGAGE AND RADAR RAINFALL MEAS-UREMENT BIAS AND RESOLUTION. National Oceanic and Atmospheric Administra-tion, Washington, DC. Climate Analysis Center. For primary bibliographic entry see Field 2B. W91-11409

SPATIAL DISTRIBUTION OF RAINFALL IN THE GREATER ATHENS AREA.

National Research Centre for the Physical Sciences Democritos, Athens (Greece). For primary bibliographic entry see Field 2B. W91-11416

KINEMATIC, DYNAMIC, AND THERMODY-NAMIC ANALYSIS OF A WEAKLY SHEARED SEVERE THUNDERSTORM OVER NORTH-ERN ALABAMA.

California Univ., Los Angeles. Dept. of Atmospheric Sciences. For primary bibliographic entry see Field 2B. W91-11417

SATELLITE-DERIVED INTEGRATED WATER-VAPOR DISTRIBUTION IN OCEANIC MIDLA-TITUDE STORMS: VARIATION WITH TITUDE STORMS: REGION AND SEASON.

Washington Univ., Seattle. Dept. of Atmospheric Sciences. For primary bibliographic entry see Field 2B. W91-11419

SQUALL LINE IN SOUTHERN GERMANY: KINEMATICS AND PRECIPITATION FORMA-TION AS DEDUCED BY ADVANCED POLARI-METRIC AND DOPPLER RADAR MEASURE-MENTS.

Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V., Oberpfaffenhofen (Germany, F.R.). Inst. fuer Physik der Atmosphare. For primary bibliographic entry see Field 2B. W91-11420

CONVECTIVE CELL IN A HURRICANE RAIN-

National Center for Atmospheric Research, Boulder, CO. For primary bibliographic entry see Field 2B. W91-11422

ASSESSMENT OF VAS-DERIVED RETRIEV-ALS AND PARAMETERS USED IN THUNDER-STORM FORECASTING.

Florida State Univ., Tallahassee. Dept. of Meteorology.

For primary bibliographic entry see Field 2B. W91-11423

DYNAMICAL FORCING AND MESOSCALE ORGANIZATION OF PRECIPITATION BANDS IN A MIDWEST WINTER CYCLONIC

Illinois Univ. at Urbana-Champaign. Dept. of Atmospheric Sciences.

For primary bibliographic entry see Field 2B. W91-11424

MULTISPECTRAL SATELLITE DATA IN THE CONTEXT OF LAND SURFACE HEAT BAL-ANCE.

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. B. J. Choudhury.
Reviews of Geophysics RVGPB4, Vol. 29, No. 2, p 217-236, May 1991. 17 fig, 3 tab, 104 ref.

Descriptors: \*Climates, \*Climatic data, \*Climatology, \*Heat balance, \*Measuring instruments, \*Meteorological data collection, \*Remote sensing, \*Satellite technology, Albedo, Cloud cover, Infrared radiation, Latent heat, Rainfall, Soil moisture, Temperature, Thermal radiation, Vegetation

Any realistic study of the Earth's climate must consider thermal interaction between the atmosphere and the land surface. During the past few years, several highly sophisticated models have been developed to describe exchanges of radiation, heat, and momentum between the land surface and the atmosphere at mesoscales and global scales. Observations on different spectral bands by instruments on board satellites can provide spatially representative values for some of the fluxes and radiative characteristics of the surface, from which the ative characteristics of the surface, from which the parameters needed for heat balance modeling have to be derived. Development of these data sets presents considerable difficulty because the relations between radiative and physical characteristics are generally nonlinear and nonunique; the radiative characteristic anny spectral band is generally determined by several physical characteristics. Relationships between different spectral observations can be used to develop hypotheses concerning the relative importance of different land surface parameters determining these observations, which would have to be confirmed by field observations. Satellite observations for visible, near-infrared, and microwave bands to estimate fluxes at frared, and microwave bands to estimate fluxes at the surface (radiative, soil, sensible, and latent heat) and surface characteristics (albedo, surface temperature, vegetation which can have a signifi-cant impact on cloud cover, rainfall, temperature, and motion fields of the atmosphere, and soil mois-ture) are presented. Interannual variations of some of these satellite observations are analyzed in terms of land surface change. (Medina-PTT) W91-11428

MONITORING OF ORGANOCHLORINE COMPOUNDS IN FINNISH INLAND WATERS POLLUTED BY PULP AND PAPER EFFLUENTS USING THE MUSSEL INCUBATION METHOD

Water and Environment District of Central Finland, Jyvaskyla (Finland). For primary bibliographic entry see Field 5A. W91-11507

HIGH-PERFORMANCE LIQUID CHROMATO-GRAPHIC STUDY ON OXIDATION PROD-UCTS OF LIGNIN AND HUMIC SUBSTANCES. Jyvaeskylae Univ. (Finland). Dept. of Chemistry. For primary bibliographic entry see Field 5A. W91-11513

NEW APPROACH TO TRACER TRANSPORT ANALYSIS: FROM FRACTURE SYSTEMS TO STRONGLY HETEROGENEOUS POROUS MEDIA.

Lawrence Berkeley Lab., CA. Earth Scien For primary bibliographic entry see Field 2F. W91-11554

DIRECT SAMPLING ION TRAP MASS SPEC-TROMETRY FOR THE RAPID DETERMINA-TION OF VOLATILE ORGANICS IN ENVI-RONMENTAL MATRICES. Oak Ridge National Lab., TN. Analytical Chemis-

For primary bibliographic entry see Field 5A. W91-11555 try Div.

LEVELS AT STREAMFLOW GAGING STA-

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. Techniques of Water-Resources Investigations of the United States Geological Survey, Chapter A19, 1990. 33p, 19 fig, 6 ref, append.

Descriptors: \*Calibrations, \*Data acquisition, \*Gaging stations, \*Handbooks, \*Stream gaging, \*Streamflow, Gages.

The various gages at a newly established gaging station are set to register the elevation of a water surface above a selected level reference surface called the gage datum. The position of this datum is intended to remain unchanged throughout the life of the station. Leveling, a procedure by which surveying instruments are used to determine the differences in elevation between points, is used to set the gages and to check them from time to time for vertical movement. Leveling, done at intervals, usually between 1 and 4 years, determines the elevations of certain points located on or near the different gages by measuring the vertical distances between those points. When the levels are run (that is, the process of leveling is carried out), the gages are checked and reset where necessary. This manual was prepared to provide, in one document, pertinent information on all aspects of leveling related to gaging station operation. It is intended for use in formal and informal training programs in which hydrographers can learn the approved techniques and develop the degree of skill needed to apply them. Procedures, instruments, and equipsurveying instruments are used to determine the which industry and develop the degree of skill needed to apply them. Procedures, instruments, and equipment, including the following, are covered: levelment, including the following, are covered: level-ing concepts and terms; equipment selection, main-tenance, and operation; checking of various types of gages; recording of field notes; adjustment of measured elevations by logical distribution of the measuring errors; and summarizing of results of leveling so they can be readily incorporated in discharge-record computations. The leveling techdischarge-record computations. The leveling techniques described agree with those outlined in surveying textbooks, with instructions prepared by the US Geological Survey (USGS) National Mapping Division, and with instructions for gagingstation leveling developed by the USGS Water resources Division. (Lantz-PTT) W91-11586

#### 7C. Evaluation, Processing and Publication

UNCERTAINTY ANALYSIS FOR A LINEAR PROGRAMMING MODEL FOR ACID RAIN ABATEMENT.

Meteorologischer Dienst der DDR, Potsdam.

Atmospheric Environment ATENBP, Vol. 25A, No. 2, p 231-240, 1991. 5 fig, 2 tab, 25 ref.

Descriptors: \*Acid rain, \*Computer models, \*Model studies, \*Water pollution sources, Acid rain effects, Air pollution, Mathematical models, Simulation, Transfer coefficients.

The influence of uncertain transfer coefficients, describing source-receptor relationships, on the un-certainty of cost-optimal emission reductions, com-puted by the RAINS (Regional Acidification In-formation and Simulation) model, was investigated. Several assumptions on the covariance between the transfer coefficients were tested. One of them was derived from simple assumptions on the under-lying air pollution transport model, thus being more realistic than purely theoretical assumptions. The assumptions of colinearity or statistical independence were not extreme bounds. The dependpendence were not extreme bounds. The dependence of the uncertainty estimates on the prescribed deposition target was also investigated. The optimum emissions of single countries were rather certain for very weak and very stringent deposition targets, having a maximum uncertainty for reading terms of the countries were the control of the countries of the countr tion targets, naving a maximum uncertainty for medium targets. As a quantitative result, the mean value of the five greatest uncertainties of the opti-mum emission of the single countries was less than or roughly equal to the assumed uncertainty of the transfer coefficients. (Mertz-PTT)

# Evaluation, Processing and Publication—Group 7C

ORGANIZATION OF THE DYNAMIC NETWORK STRUCTURE IN THE DIMENSION OF TIME.

Eidgenoessische Technische Hochschule, Zurich (Switzerland). Biological Reaction Engineering

For primary bibliographic entry see Field 2H. W91-10492

EFFECT OF COASTAL SEA LEVEL FORCING ON INDIAN RIVER BAY AND REHOBOTH BAY, DELAWARE.

Delaware Univ., Newark. Coll. of Marine Studies. For primary bibliographic entry see Field 2L. W91-10494

ESTIMATING THE EFFECTS ON THE RE-GIONAL PRECIPITATION CLIMATE IN A SEMIARID REGION CAUSED BY AN ARTIFI-CIAL LAKE USING A MESOSCALE MODEL. Uppsala Univ. (Sweden). Meteorologiska Institutionen.

For primary bibliographic entry see Field 2B. W91-10502

ADVANCES IN WIND AND WATER EROSION

Minnesota Univ., St. Paul. Dept. of Agricultural Engineering.

For primary bibliographic entry see Field 2J. W91-10509

RUSLE: REVISED UNIVERSAL SOIL LOSS

RUSLE: REVISED UNIVERSAL SOIL

EQUATION.

Agricultural Research Service, Tucson, AZ.

For primary bibliographic entry see Field 2J.

W91-10510

WEPP: A NEW GENERATION OF EROSION PREDICTION TECHNOLOGY.

National Soil Erosion Lab., West Lafayette, IN. For primary bibliographic entry see Field 2J. W91-10511

WEPP: SOIL ERODIBILITY EXPERIMENTS FOR RANGELAND AND CROPLAND SOILS. National Soil Erosion Lab., West Lafayette, IN. For primary bibliographic entry see Field 2J. W91-10512

THREE-DIMENSIONAL SIMULATION OF AIRFLOW AND OROGRAPHIC RAIN OVER THE ISLAND OF HAWAII.

Scripps Institution of Oceanography, La Jolla, CA. For primary bibliographic entry see Field 2B. W91-10517

NUMERICAL SIMULATION OF WA QUALITY IN TOKYO BAY. Japan NUS Co. Ltd., Osaka. For primary bibliographic entry see Field 5B. W91-10528 SIMULATION OF WATER

INVESTIGATION ON TURBIDITY AND FLOW PATTERNS IN HALF-CLOSED SEA AREA. Chemical Inst. for Industry, Tsukuba (Japan). For primary bibliographic entry see Field 5B. W91-10532

PERSONAL COMPUTER SYSTEM SUPPORTING WATER QUALITY MANAGEMENT IN EUTROPHICATED BAY.

Osaka Univ. (Japan). For primary bibliographic entry see Field 5G. W91-10582

EAST ASIAN SEAS: HYPOTHETICAL OIL SPILL TRAJECTORIES.
Resource Systems Inst., Honolulu, HI.

primary bibliographic entry see Field 5B.

COMPUTER VISUALIZATION SYSTEM FOR SEDIMENT POLLUTION IN JAPAN.
Chiba Inst. of Tech., Narashino (Japan). Dept. of

Child Engineering.
K. Taki, A. Takemoto, and M. Hosomi.
Marine Pollution Bulletin MPNBAZ, Vol. 23, p
761-763, 1991. 2 fig. 1 ref.

Descriptors: \*Computer models, \*Computer programs, \*Japan, \*Model studies, \*Path of pollutants, \*Pollution load, \*Sediment contamination, Data interpretation.

Although sediment pollution is one of the signifi-cant factors in evaluating the mechanisms of water cant factors in evaluating time mechanisms of water pollution, pollutant movements in the sediment make understanding this mechanism difficult. Sedi-ment pollution has been investigated and analyzed by individual municipal organizations, but no com-prehensive study has analyzed sediment pollution. on a national scale in Japan. Sets of data (20,306) measuring 69 parameters, such as oxidation-reduction potential and trace metal levels, were collected from all 47 prefectures for a period of twelve years, from 1972 to 1983. The results were modelled and graphed for each prefecture and sea area, as a comprehensive and direct approach to understanding the pollution. This computation appears to be highly effective in comparing and analyzing the pollution on a comprehensive scale. (Brunone-PTT)
W91-10609

DEVELOPMENT OF RISK ASSESSMENT METHODOLOGY FOR LAND APPLICATION AND DISTRIBUTION AND MARKETING OF MUNICIPAL SLUDGE.

Environmental Protection Agency, Washington, DC. Office of Research and Development. For primary bibliographic entry see Field 5E. W91-10708

CASE STUDIES IN DATA ANALYSIS. RDP, Inc., Waltham, MA. For primary bibliographic entry see Field 2B. W91-10733

ESTABLISHMENT OF A GROUNDWATER RE-SEARCH DATA CENTER FOR VALIDATION OF SUBSURFACE FLOW AND TRANSPORT MODELS

Butler Univ., Indianapolis, IN. Holcomb Research For primary bibliographic entry see Field 2F. W91-10736

INVESTIGATION OF LOCAL SCOUR IN CO-HESIONLESS SEDIMENTS USING A TUNNEL-MODEL. Waterloopkundig Lab. te Delft (Netherlands). For primary bibliographic entry see Field 2J. W91-10746

MONTHLY MEAN DISCHARGE AT AND BE-TWEEN SELECTED STREAMFLOW-GAGING STATIONS ALONG THE MISSISSIPPI, MIN-MESOTA, AND ST. CROIX RIVERS, 1932-87. Geological Survey, St. Paul, MN. For primary bibliographic entry see Field 2E. W91-10760

PRECONDITIONED CONJUGATE-GRADIENT 2 (PCG2), A COMPUTER PROGRAM FOR SOLVING GROUND-WATER FLOW EQUA-TIONS.

Geological Survey, Denver, CO. M. C. Hill.

M.C. Hill. Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Feder-al Center, Denver, Co 80225-0425. Water-Re-sources Investigations Report 90-4048, 1990. 43p, 3 fig. 27 ref.

Descriptors: \*Computer models, \*Computer programs, \*Groundwater movement, \*Mathematical equations, \*Model studies, Data interpretation, Handbooks, Hydraulic head, Mathematical analytics, Statistical post-rich, Statistical sis, Statistical analysis.

PCG2 is a numerical code to be used with the US Geological Survey modular three-dimensional, finite-difference, groundwater flow model. PCG2 uses the preconditioned conjugate-gradient method to solve the equations produced by the model for hydraulic head. Linear or nonlinear flow conditions may be simulated. PCG2 includes two preconditioning options: modified incomplete Cholesky preconditioning, which is efficient on scalar computers; and, polynomial preconditioning, which requires less computer storage and, with modifications that depend on the computer used, is most efficient on vector computers. Convergence of the solver is determined using both head-change and residual criteria. Nonlinear problems are solved using Picard iterations. This documentation provides a description of the preconditioned, conjugate-gradient method and the two preconditioners, detailed instructions for linking PCG2 to the modular model, sample data inputs, a brief description of PCG2, and a FORTRAN listing. (Author's abstract) abstract) W91-10764

STATISTICAL SUMMARIES OF SELECTED IOWA STREAMFLOW DATA THROUGH SEP-**TEMBER 30, 1988.** 

Geological Survey, Iowa City, IA. For primary bibliographic entry see Field 2E. W91-10770

DEVELOPMENT AND IMPLEMENTATION OF A REMEDIAL INVESTIGATION WORK PLAN AND DATA MANAGEMENT SYSTEM. For primary bibliographic entry see Field 5G. W91-10799

OCCURRENCE OF APPENDIX IX ORGANIC CONSTITUENTS IN DISPOSAL SITE CONSTITUENTS GROUND WATER.

Lockheed-EMSCO, Las Vegas, NV. For primary bibliographic entry see Field 5B. W91-10801

MODEL OF AMMONIA VOLATILIZATION FROM APPLIED UREA. V. THE EFFECTS OF STEADY-STATE DRAINAGE AND EVAPORA-

Oxford Univ. (England), Soil Science Lab. For primary bibliographic entry see Field 3F. W91-10805

MODEL OF AMMONIA VOLATILIZATION FROM APPLIED UREA, VI, THE EFFECTS OF TRANSIENT-STATE WATER EVAPORATION. Oxford Univ. (England). Soil Science Lab. For primary bibliographic entry see Field 3F. W91-10806

UNIT HYDROGRAPHS FOR DEVELOPING DESIGN FLOOD HYDROGRAPHS.

Illinois State Water Survey Div., Champaign.
Office of Surface Water Resources and Systems Analysis.

For primary bibliographic entry see Field 2E. W91-10809

FAST ALGORITHM FOR AUTOMATICALLY COMPUTING STRAHLER STREAM ORDER. Geological Survey, Reston, VA. Water Resources

For primary bibliographic entry see Field 2J. W91-10818

ECOTOXICOLOGICAL EFFECTS ASSESS-MENT: A COMPARISON OF SEVERAL EX-TRAPOLATION PROCEDURES.

Rijksinstituut voor de Volksgezondheid en Milieu-hygiene, Bilthoven (Netherlands). For primary bibliographic entry see Field 5A. W91-10830

#### Field 7—RESOURCES DATA

# Group 7C—Evaluation, Processing and Publication

DISPERSAL DYNAMICS OF GROUNDWATER BACTERIA

Lund Univ. (Sweden). Dept. of Ecological Chemistry. For primary bibliographic entry see Field 5B. W91-10843

SEASONAL INFLUENCES ON THE SEDI-MENT TRANSPORT CHARACTERISTICS OF THE SACRAMENTO RIVER, CALIFORNIA. Bradford Univ. (England). Dept. of Civil Engineering and Structural Engineering. For primary bibliographic entry see Field 2J. W91-10847

ESTIMATION OF THE MEAN FIELD BIAS OF RADAR RAINFALL ESTIMATES.

Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research. For primary bibliographic entry see Field 2B. W91-10857

USE OF SINGLE-DOPPLER RADAR FOR ES-TIMATING MAXIMUM HAILSTONE SIZE. National Severe Storms Lab., Norman, OK. For primary bibliographic entry see Field 2B. W91-10858

VISUAL INTERPRETATION OF A LANDSAT MOSAIC OF THE OKAVANGO DELTA AND

School of Agriculture, University of Bophuthats-wana, South Africa.

For primary bibliographic entry see Field 2H. W91-10879

COMPUTATION OF AVERAGE SEASONAL GROUNDWATER FLOWS IN PHREATIC AQ-UIFER-RIVER SYSTEM.
Indian Inst. of Tech., Bombay. Dept. of Civil

Engineering.
For primary bibliographic entry see Field 2F.
W91-10910

GROUNDWATER MANAGEMENT MODEL FOR SALT LAKE COUNTY, UTAH WITH SOME WATER RIGHTS AND WATER QUAL-ITY CONSIDERATIONS. Utah State Univ., Logan. Dept. of Civil and Envi-ronmental Engineering. For primary bibliographic entry see Field 4B. W91-10911

LC-50 ESTIMATES AND THEIR CONFIDENCE INTERVALS DERIVED FOR TESTS WITH ONLY ONE CONCENTRATION WITH PAR-TIAL EFFECT.

stitute of Environmental Sciences TNO, Delft (Netherlands).

For primary bibliographic entry see Field 5C. W91-10930

HUMIC SUBSTANCES IN ACID SURFACE WATERS; MODELLING ALUMINIUM BINDING, CONTRIBUTION TO IONIC CHARGEBALANCE, AND CONTROL OF PH. Freshwater Biological Association, Ambleside (England). Windermere Lab. For primary bibliographic entry see Field 5C. W91-10933

COMPARATIVE STUDY AND MATHEMATI-CAL MODELING OF TEMPERATURE, LIGHT AND GROWTH OF THREE MICROALGAE POTENTIALLY USEFUL FOR WASTEWATER TREATMENT.

Laval Univ., Quebec. Groupe de Recherche en Recyclage Biologique et Aquiculture. For primary bibliographic entry see Field 5D. W91-10937

NUMERICAL MODELLING OF VERTICAL GROUND MOVEMENTS IN EXPANSIVE

Saskatchewan Univ., Saskatoon. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2G.
W91-10945

METHOD TO DETERMINE THE FORMA-TION CONSTANTS OF LEAKY AQUIFERS, AND ITS APPLICATION TO PUMPING TEST

Technische Univ., Vienna (Austria). Abt. Geo-

Physics. F. Kohlbeck, and A. Alvarez. Ground Water GRWAAP, Vol. 29, No. 3, p 425-429, May/June 1991. 3 tab, 21 ref.

Descriptors: \*Aquifer characteristics, \*Computer models, \*Computer programs, \*Leaky aquifers, \*Model studies, \*Pumping tests, Colombia, Drawdown, Flow equations, Leakage, Observation wells, Storage coefficient, Transmissivity.

A great number of computer programs exist for the calculation of aquifer parameters from pumping test data; however, only a few use the general equation of Hantush and Jacob for leaky aquifers. A method to calculate aquifer transmissivity, storage coefficient, and the leakage coefficient from age coefficient, and the leakage coefficient from pumping test data for a leaky aquifer has been developed. The method is carried out by a computer program and is based on a minimization of the sum of squares of differences between draw-down in the observation well and the theoretical values from the Hantush and Jacob formula. No user defined starting points are necessary. Random error estimates for the parameters have been defined. The method was applied using data from pumping tests performed in leaky aquifers at the Cauca River Valley, Colombia. It was found that the computer method compares well with the conventional methods and that the standard deviation is always lowest with the computer's least-squares approximation. Furthermore, the computer approximation. Furthermore, the computer method has incorporated an error estimation for the parameters. (Fish-PTT)
W91-10961

OIL SPILL RISK SIMULATION MODEL. Kuwait Inst. for Scientific Research, Safat. Envi-ronmental and Earth Sciences Div. For primary bibliographic entry see Field 5B. W91-11001

COOPERATIVE DATA ON REGIONAL WATER USE: THE GREAT LAKES REGIONAL WATER USE DATA REPOSITORY.

Great Lakes Basin Commission, Ann Arbor, MI. For primary bibliographic entry see Field 6D. W91-11010

MODELING LAKE ERIE AS A STOCHASTIC LINEAR RESERVOIR. Cincinnati Univ., OH. Dept. of Civil and Environ-

Cincinnati Univ., OH. Dept. of Civil and Environ-mental Engineering. S. G. Buchberger. IN: International and Transboundary Water Re-sources Issues. American Water Resources Asso-ciation, Bethesda, Maryland, 1990. p 259-268, 4 fig, 2 tab, 12 ref. Ohio Sea Grant Program Project R/ OE-7-PD, NOAA Grant NA88AA-D-SG094.

Descriptors: \*Lake Erie, \*Linear analysis, \*Model studies, \*Stochastic hydrology, Graphical analysis, Hydraulic properties, Reservoirs, Statistical analysis, Water level.

A new approach is presented for forecasting water levels in Lake Erie. In contrast to traditional hy-draulic routing models, the proposed method rep-resents a probability routing scheme. Lake Erie visualized as a stochastic linear reservoir fed by white noise. Starting with mass conservation, ex-pressions are derived for the mean and variance of storage in the stochastic linear reservoir under transient and asymptotic conditions. The reservoir drift function is introduced as a method to evaluate model parameters and as a means to describe the self-regulating behavior of the stochastic linear reservoir. The calibrated model was used to forecast mean September water levels for Lake Erie over a

5-yr period. Annual changes in Lake Erie water 5-yr period. Annual changes in Lake Erie water levels were then computed and plotted against the respective starting lake levels. For example, the mean September water levels in 1987 and 1988 are 5.22 and 3.72 ft, respectively. The corresponding change in elevation is -1.50 ft. This value is plotted against 5.22 ft. Repeating this process for all 130 observations yields 129 points. The change in water level is then regressed against the starting lake level using classic least squares techniques. The resulting regression line, defines the September drift function for Lake Erie. (See also W91-11003) (Lantz-PTT) W91-11029 W91-11029

AMBIENT AIR CO-MODELING IN ALASKA. Alaska Univ., Fairbanks. School of Engineering. R. A. Johnson, M. Anderson, and E. Lilly. IN: Environmental Problems and Solutions: Greenhouse Effect, Acid Rain, Pollution. Hemisphere Publishing Corporation, New York. 1990. p 61-78. 12 fig, 2 tab, 30 ref.

Descriptors: \*Air pollution, \*Air quality, \*Alaska, \*Carbon monoxide, \*Clean Air Act, \*Environmental monitoring, \*Mathematical models, \*Model studies, \*Path of pollutants, Air temperature, Computer models, Environmental Protection Agency, Meteorological data, Meteorological data collection, Model testing, Prediction.

According to the Clean Air Act of 1970, maximum allowable ambient carbon monoxide levels are 9 ppm for eight hours and 35 ppm for one hour. The frequent violation of these standards in Fairbanks and, until very recently, in Anchorage, Alaska, has prompted the US Environmental Protection Agency to encourage strategies intended to reduce Agency to encourage strategies intended to reduce carbon monoxide concentrations. To help gauge the relative merits of various strategies, computer models are commonly used to predict both carbon monoxide emissions and the resultant movement of carbon monoxide through the atmosphere. This study has focused on an assessment of MOBILE3 as a mobile source emissions model and CALINEA as a line course diseasement. as a line source dispersion model in Alaska. We have modified MOBILE3 to allow for the prediction of emissions at ambient temperatures below 0 F and have incorporated available meteorological data for Fairbanks to evaluate CALINE4. The use ese models does allow the approximation trends over time in carbon monoxide levels in trends over time in carbon monoxide levels in Fairbanks, but a lack of more detailed data precludes quantitative prodiction peaks and detailed spatial trends. However, the results to date indicate that these models have the potential to predict carbon monoxide levels in Alaska. (See also W91-11066) (Author's abstract) W91-11070

INFLUENCE OF GREEN PLANTS ON THE WORLD CARBON BUDGET.

For primary bibliographic entry see Field 2K. W91-11071

MAPS OF THE '400-FOOT,' '600-FOOT,' AND ADJACENT AQUIFERS AND CONFINING BEDS, BATON ROUGE AREA, LOUISIANA. Geological Survey, Baton Rouge, LA. Water Re-

For primary bibliographic entry see Field 2F. W91-11086

GEOHYDROLOGY AND SIMULATION OF GROUND-WATER FLOW IN THE MESILLA BASIN, DONA ANA COUNTY, NEW MEXICO, AND EL PASO COUNTY, TEXAS.

Geological Survey, Albuquerque, NM. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-11088

HYDROLOGIC, METEOROLOGICAL, AND UNSATURATED-ZONE MOISTURE-CONTENT DATA, FRANKING LAKE PLAYA, INYO COUNTY, CALIFORNIA.

# Evaluation, Processing and Publication—Group 7C

Geological Survey, Denver, CO. Water Resources For primary bibliographic entry see Field 2F.

ANALYSIS OF GROUND-WATER FLOW IN THE A-SAND AQUIFER AT PARAMARIBO, SURINAME, SOUTH AMERICA.
Geological Survey, Tallahassee, FL. Water Re-

For primary bibliographic entry see Field 2F. W91-11090

GEOHYDROLOGY AND SIMULATION OF FLOW IN THE CHICOT AQUIFER SYSTEM OF SOUTHWESTERN LOUISIANA. Geological Survey, Baton Rouge, LA. Water Re-

For primary bibliographic entry see Field 2F. W91-11100

CALIBRATION OF A TEXTURE-BASED MODEL OF A GROUND-WATER FLOW SYSTEM, WESTERN SAN JOAQUIN VALLEY, CALIFORNIA.

Geological Survey, Sacramento, CA. Water Resources Div.

bibliographic entry see Field 5B.

HYDROGEOLOGY OF THE VALLEY-FILL AQUIFER AT OWEGO, TIOGA COUNTY, NEW YORK.

Geological Survey, Albany, NY. Water Resources Div.

For primary bibliographic entry see Field 2F. W91-11105

U.S. GEOLOGICAL SURVEY FEDERAL-STATE COOPERATIVE WATER-RESOURCES PRO-GRAM FISCAL YEAR 1989. Geological Survey, Reston, VA. Water Resources

For primary bibliographic entry see Field 7B. W91-11109

METHODOLOGY TO DERIVE WATER-QUAL-ITY TRENDS FOR USE BY THE NATIONAL WATER SUMMARY PROGRAM OF THE U.S. GEOLOGICAL SURVEY.

Geological Survey, Reston, VA. Water Resources

For primary bibliographic entry see Field 7B.

EXECUTIVE SUMMARY-ASSESSING EXECUTIVE SUMMARY-ASSESSING THE RESPONSE OF EMERALD LAKE, AN ALPINE WATERSHED IN SEQUOIA NATIONAL PARK, CALIFORNIA, TO ACIDIFICATION DURING SNOWMELT USING A SIMPLE HY-DROCHEMICAL MODEL.

Geological Survey, Doraville, GA. Water Re-

sources Div.
R. P. Hooper, C. T. West, and N. E. Peters.
Pooks and Open Files Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 90-357, 1990. 4p.

Descriptors: "Acid rain, "Acid rain effects, "Acidification, "Emerald Lake, "Model studies, "Path of pollutants, "Snow, "Water pollution sources, Alkaninty, Alpine Lake Forecaster Model, California, Hydrogen ion concentration, Lake chemistry, Nitrates, Simulation analysis, Snowmelt, Snowpack, Sulfates.

A simple process-oriented model, called the Alpine Lake Forecaster (ALF), was constructed using data collected from the Integrated Watershed Study of Emerald Lake, Sequoia National Park, California. ALF is able to capture the basic solute patterns during snowmelt in this alpine catchment where groundwater is a minor contributor to streamflow. It includes an empirical representation of regiment uniperal weathering as the only alkalinia. of primary mineral weathering as the only alkalini-ty generating mechanism. During a heavy snow

year, such as the one used for calibrating the model, the model accurately simulated the surface water chemical change in response to the initial ionic pulse from the snowpack and to the dilution that occurs at peak snowmelt. During a light snow year, there is evidence that cation exchange may be a substantial source of alkalinity during the initial phases of snowmelt. Because the model does not consider cation exchange, it over-predicts the acidification during the initial period of snowmelt, and therefore is a conservative predictor. Howevand therefore is a conservative predictor. However, the minimum alkalinity observed in the main inflows to Emerald Lake and in the lake outflow is inflows to Emeraid Lake and in the lake outlinow is accurately simulated by the model. The representation of the lake as simply a mixing volume with no additional chemical reactions is supported by the observations. The model predicts a change of 2 to 5 microequiv/L in the minimum alkalinity of the lake outflow during snowmelt if the deposition of both nitrate and sulfate were doubled and a moderate acidic pulse is released from the snowpack. This change would not be sufficient to acidify the lake. Atmospheric deposition would have to in-crease between two and 18 times the current loadcrease between two and 18 times the current load-ings of both nitrate and sulfate to exhaust the alkalinity of the lake; the precise increase depends on hydrologic conditions and on the pattern of solute release from the snowpack. An acidic rain-storm that exhausted the alkalinity of the lake was observed during summer 1984 after the lake had stratified, and is the likely cause of the acidification of Emerald Lake. (Lantz-PTT)

OVERVIEW OF U.S. GEOLOGICAL SURVEY WATER-RESOURCES INFORMATION PRO-GRAMS.

For primary bibliographic entry see Field 10D. W91-11166

MINNESOTA DISTRICT, WATER RE-SOURCES DIVISION: INFORMATION AND TECHNICAL ASSISTANCE. For primary bibliographic entry see Field 2F. W91-11167

PLANNED STUDIES OF AGRICHEMICALS IN GROUND AND SURFACE WATER IN THE MID-CONTINENTAL UNITED STATES.

Geological Survey, Reston, VA.
For primary bibliographic entry see Field 5B. W91-11168

SOIL SURVEY INFORMATION SYSTEM: A USER FRIENDLY SOIL INFORMATION

J. L. Anderson, and P. C. Robert. J. L. Anderson, and F. C. Robert. In: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Man-agement. Freshwater Foundation, Navarre, Minne-sota. 1989. p 155-162, 5 fig. 7 ref.

Descriptors: \*Computer programs, \*Data interpretation, \*Data storage and retrieval, \*Information systems, \*Nonpoint pollution sources, \*Soil survey Information System, \*Soil surveys, Computers, Databases, Digital map data, Drainage, Land management, Land use, Maps, Soil management, Soil properties, Vegetation.

Modern soil surveys include soil maps, soil descrip-tions, soil properties, and various soil interpreta-tions prepared for specific uses. One common way to display soil survey information is to create a to display soil survey information is to create a series of simple interpretive maps. This can be done very easily on a microcomputer using the menu-driven Soil Survey Information System (SSIS). The SSIS can access, sort, display, highlight, and print any soil survey data for one section at a time or a similar gridded area. SSIS can also display and overlay other digitized maps such as land use, ownership, vegetation cover types, roads, and drainage. SSIS requires detailed county soil survey reports. The soil survey base map sheets are digitized using a high resolution scanner. Input of soil descriptions, soil properties, and soil interpre-tations is also executed with an interactive program. Maps and summary tapes are displayed on monitors and printed using a standard dot matrix

printer. There continues to be a growing interest in the use of the SSIS for land appraisal, farm management, soil sample location selection, conservation planning, government and local programs, and education. In the future, additional application software will be developed for soil and crop management and soil and the solution of agement, soil and timber management, and soil and road management. (See also W91-11162) (Korn-PTT W91-11174

ATLAS\*GRAPHICS: AN AFFORDABLE MAP-

British Columbia Ministry of Environment, Victoria. Waste Management Branch. L. E. Danielson.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Man-agement. Freshwater Foundation, Navarre, Minnesota. 1989. p 163-166.

Descriptors: \*Computer programs, \*Computerized maps, \*Costs, \*Geographic information systems, \*Landsat images, \*Mapping, \*Nonpoint pollution sources, Data quality control, Data requirements, Digital map data, Maps, Training.

Mapping systems are useful for analyses of data and for communication where geographic location is an important dimension of the information con-tent. It is especially useful for communicating ideas tent. It is especially useful for communicating ideas and concepts because words or text can be supplemented with the visual picture as shown by the map. A map can be computer generated to display information based upon some theme, such as groundwater quality, using a fixed boundary (e.g., county, state, etc.). ATLAS\*GRAPHICS is a thematic mapping system that is relatively inexpensive and it may be a supplementation. matic mapping system that is reliatively inexpensive and is easy to use. It is useful in cases where tasks do not require a true Geographic Information System (GIS) or where budgets are limited. Capabilities of the ATLAS\*GRAPHICS software package include data presentation, construction of overlays, and digitizing new region boundaries. However, several aspects of a mapping system though the second Microscopic according to the control of the several Microscopic and the second However, several aspects of a mapping system should be noted. Mapping systems require a great deal of good quality data. If the quality of the data is inadequate, then the output will suffer. Data also must be tailored to the region being analyzed. If new regions are digitized, data must be available for that region. In addition, the new user must be willing to spend time necessary to learn and operate the system. However, the use of a mapping system will improve retention of the concepts, ideas and information presented, and it will help analyze data for its geographical importance. (See also W91-11162) (Korn-PTT)

NATIONAL PESTICIDE USAGE DATA BASE. L. P. Gianessi.

I.F. Connessu.

IN: Agrichemicals and Groundwater Protection:
Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 167-173, 3 tab, 8 ref.

Descriptors: \*Agricultural chemicals, \*Data collections, \*Data storage and retrieval, \*Databases, \*Nonpoint pollution sources, \*Pesticides, \*Water quality, Estimating, Groundwater pollution, Maps, Policy making, Public policy, Regional analysis.

It is often assumed by newly formed public policy-making agencies that there is an up-to-date data-base on pesticide usage available for each county, state, region, or watershed. Unfortunately this not the case. In response to this need, a National Pesticide Usage Data Base has been developed which contains estimates of the average annual usage of twenty-five specific active ingredients in pesticides by crop at the county level of detail. Generally, these estimates are calculated using two coefficients: the percent of acres that are treated coefficients: the percent of acres that are treated and the average annual application rate per treated and the average annual application rate per treated acre. Several operations are performed with these average state coefficients. They are used to calculate county-level estimates assuming that the state average usage coefficients apply uniformly to the counties in the state. Maps are then prepared that show the county usage pattern for the nation. The

#### Field 7—RESOURCES DATA

#### Group 7C—Evaluation, Processing and Publication

purpose behind the development of the National Pesticide Usage Data Base was to be able to evaluate the effects of national policies. National policies can be evaluated in terms of their relative impacts on certain regions, crops, and pesticides. The data base was used in an evaluation of the potential impacts of groundwater protection strategies for the nation. It was concluded that about one-third of the nation's counties can be classified with a potential for groundwater contamination as a result of not only having vulnerable soil conditions but also having significant usage of highly soluble pesticides. (See also W91-11162) (Korn-PTT)

CROP DATA MANAGEMENT SYSTEMS, INC. MEETING CALIFORNIA'S PESTICIDE REGULATION CHALLENGE.

For primary bibliographic entry see Field 5G. W91-11177

APPLICATION OF THE DRASTIC MAPPING SYSTEM FOR EVALUATING GROUND WATER POLLUTION POTENTIAL IN OHIO. Ohio Dept. of Natural Resources, Columbus. Div. of Water.

For primary bibliographic entry see Field 5B. W91-11178

SOIL TEC: A COMPUTERIZED SOIL-SPECIF-IC FERTILIZER APPLICATION SYSTEM. CENEX/Land O'Lakes, St. Paul, MN 55164-0089.

IN: A grichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 357-361.

Descriptors: \*Automation, \*Computer programs, \*Data processing, \*Fertilizer management, \*Fertilizers, \*Nonpoint pollution sources, Cost analysis, Crop production, Digital map data, Performance evaluation, Soil classification, Soil properties.

Fertilizer is one of the primary inputs a crop producer must consider when planning a crop producer. Eretilizer application or placement is very important because it affects application rate and other resources. Placement of certain fertilizer materials is of utmost concern since fertilizer rate reductions of up to 79% can occur with some forms of application equipment. Computer technology can now be used to vary the blend of fertilizer and the application rate as a field is crossed. This new method of fertilization is called the SOILECTION SYSTEM. The identification of different soils in a field is accomplished by using both the soil survey map and an infrared photograph. A digitized map is then generated that identifies various areas using different colors. Soils are labeled according to texture or heavy, medium, and light soils. After the map is created, soil samples are taken in each area. Fertility results and recommendations are made based on the yield goals set for each area. The computer can then take a specific field and break it down into the soil types. Fertilizer requirements are then put in the program and a recommendation printout is produced of materials needed and cost per acre. After the recommendation prosess the fertilizer can be spread using a custom designed six to eight compartment fertilizer tox with dispensing wheels. The distribution of fertilizer is controlled by a microprocessor thereby allowing the precise amount of fertilizer from each compartment to be dispensed. (See also W91-11162) (Korn-PTT)

SIMULATION OF PRECIPITATION BY WEATHER TYPE ANALYSIS, Geological Survey, Denver, CO. Water Resources

Div. For primary bibliographic entry see Field 2B. W91-11230

GEOSTATISTICAL CHARACTERISTICS OF THE BORDEN AQUIFER. Manitoba Univ., Winnipeg. Dept. of Geological Engineering. For primary bibliographic entry see Field 2F. W91-11234

IMPROVED ANALYSIS OF GRAVITY DRAIN-AGE EXPERIMENTS FOR ESTIMATING UN-SATURATED SOIL HYDRAULIC FUNCTIONS. Idaho National Engineering Lab., Idaho Falls. For primary bibliographic entry see Field 2G. W91-11237

AQUATIC HABITAT MEASUREMENT AND VALUATION: IMPUTING SOCIAL BENEFITS TO INSTREAM FLOW LEVELS.

National Ecology Research Center, Fort Collins,

A. J. Douglas, and R. L. Johnson. Journal of Environmental Management JEVMAW, Vol. 32, No. 3, p 267-280, April 1991. 2 fig, 21 ref.

Descriptors: \*Aquatic habitats, \*Economic aspects, \*Fisheries, \*Instream flow, \*Model studies, \*Streamflow, Benefits, Fish populations, Social aspects, Streamflow depletion, Value, Water allocation, Water resource management.

Since significant public benefits depend heavily on the retention of relatively abundant, free-flowing water within the stream channels, conflicts arising from the allocation of riverine resources are resolved at the bargaining table. Economics offer some useful insights in analyzing conflict resolution within the context of water allocation problems. The relation between aquatic habitat estimation techniques, and the socially optimal allocation of non-market resources are examined in detail. The physical habitat simulation system (PHAB-SIM) developed by the U.S. Fish and Wildlife Service provides a quantitative estimate of the available weighted usable aquatic habitat at various streamflow levels for a given streamreach. A PHABSIM prediction can be displayed as a production frontier in which units of habitat are on one axis, and some market output, such as fish production, is on the other axis. A conceptual problem arises from attempts to match a social benefits trade-off curve with PHABSIM outputs when there is no optimal single steady-state streamflow because the various finish species have evolved through highly variable hydrologic conditions. Angling success is not always a monotonically increasing function of streamflow. The PHAB-SIM model can be combined with an aggregate streamflow benefits curve to elect an optimal streamflow benefits curve to receive any optimal streamflow of the non-market benefits provided by wildlife habitat even more broadly and may lead to a deeper appreciation of the social value of naturally reproducing wildlife populations. (Geiger-PTT)

KNOWLEDGE-BASED SYSTEMS AND OPERATIONAL HYDROLOGY.

Manitoba Univ., Winnipeg. Dept. of Civil Engineering. S. P. Simonovic.

Canadian Journal of Civil Engineering CJCEB8, Vol. 18, No. 1, p 1-11, February 1991. 3 fig, 38 ref, append.

Descriptors: \*Artificial intelligence, \*Canada, \*Expert systems, \*Network design, \*Operational hydrology, \*Stream gaging, Computers, Hydrology, Open-channel flow, Project planning.

Knowledge-based systems have been known to hydrologists for almost a decade. The application of knowledge-based systems technology in hydrology is natural and appropriate because it contains numerous procedures developed from theory, practice, and experience. Knowledge-based systems of artificial intelligence are reviewed as they apply to hydrology, including an expert system designed to select a suitable method for flow measurement in open channels. An expert system is a computer model consisting of the following components: user interface, explanation subsystem, knowledge base, knowledge acquisition subsystem, knowledge base,

and inference engine. Problems in the field of hydrology can be categorized by: (1) inherent imprecision; (2) paucity and incompleteness of data; (3) fuzzy decision processes, and (4) heavy reliance on expert views (which are themselves vague and imprecise). Experts can function in various capacities in hydrology, including data collection and analysis, storing theoretical knowledge, and storing expertise gained from operational experience. Several expert systems already exist, including HYDRO, HSPF, FLOOD ADVISOR, EXSRM, and SWMM, which cover a wide range of hydrologic problem-solving needs. A decision support system was developed for Environment Canada as a way of selecting the method of flow measurement for open channels. The system will be help Environment Canada in three ways: (1) provided physical conditions at a measurement site, it recommends a list of gaging methods that match service needs and policies; (2) based on the recommended its and additional information about available equipment and structures at the measurement site, the system proposes the most appropriate method; and (3) for the recommended method, detailed instructions are provided to help the user to prepare to take measurements. The system also can be used in planning. (Rochester-PTT)

HYDROMETRIC DATA COLLECTION AND INTERPRETATION IN THE PRAIRIE PROVINCES AND NORTHWEST TERRITORIES.

Environment Canada, Ottawa (Ontario). Water Resources Branch. For primary bibliographic entry see Field 7A. W91-11278

SATELLITE-DERIVED REFLECTANCE OF SNOW-COVERED SURFACES IN NORTHERN MINNESOTA

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. D. K. Hall, W. M. Kovalick, and A. T. C. Chang. Remote Sensing of the Environment RSEEA7, Vol. 33, No. 2, p 87-96, August 1990. 4 fig, 4 tab, 33 ref.

Descriptors: \*Data acquisition, \*Reflectance, \*Reflectance techniques, \*Remote sensing, \*Satellite technology, \*Snow cover, Albedo, Energy, Landsat images, Snow depth, Thermal conductivity.

Its high albedo and low thermal conductivity make snow a key component of the global energy balance. Snow depth and reflectance are crucial inputs to General Circulation Models (GCMs), Satellite data from the Landsat Thematic Mapper (TM) have been used to estimate the reflectance of snow and snow-covered surfaces integrated over part (0.45-0.90 micrometers) of the reflective range of the electromagnetic spectrum. The integrated reflectance, Ri, has been computed for snow-covered agricultural and forested areas, and a frozen lake in northern Minnesota using Landsat TM scenes acquired in November 1984 and January 1985. TM-derived reflectances, corrected for atmospheric effects, are mapped for subscenes within the Minnesota TM scenes and reflectances have been color coded. The average Ri within the November 1984 subscene was 0.429 (+/-0.176) whereas the average Ri within the January 1985 subscene was 0.669 (+/-0.236). Snow reflectance is known to increase with solar and sensor zenith angle. The solar zenith angle was 70 degrees at the scene center of the 17 November 1984 scene, and 75 degrees at the scene center of the 04 January 1985 scene. Both areas were predominately snow covered. Lowest reflectances (near 0%) were found in the non-snow-covered agricultural fields. Reflectances of lake ice in the January scene averaged 0.957 (+/-0.0008). In the future, the Moderate Resolution Imaging Spectrometer (MODIS), apart of the Earth Observing System, will enable calculation of Ri over most of the reflective part of the electromagnetic spectrum. Ri may then be used, along with bidirectional reflectance data, to calculate snow albedo, an important input to GCMs and regional energy balarce models. (Author's abstract)

#### Evaluation, Processing and Publication—Group 7C

RELATIONSHIP OF MSS AND TM DIGITAL DATA WITH SUSPENDED SEDIMENTS, CHLOROPHYLL, AND TEMPERATURE IN MOON LAKE, MISSISSIPPI. Agricultural Research Service, Beltsville, MD. Hydrology Lab.

Hydrology Lab.

J. C. Ritchie, C. M. Cooper, and F. R. Schiebe.

Remote Sensing of the Environment RSEEA7,
Vol. 33, No. 2, p 137-148, August 1990. 6 fig, 6 tab,

Descriptors: \*Chlorophyll, \*Data acquisition, \*Digital map data, \*Remote sensing, \*Satellite technology, \*Suspended sediments, \*Temperature, \*Water quality monitoring, Correlation analysis, Landsat images, Multi-spectral scanner, Reflec-

Remote sensing technology can be used for moni-toring changes in surface water quality parameters to provide a rapid assessment of both spatial and temporal variability in surface water quality. Most of the studies that use Landsat data have been of the studies that use Landau data nave been made using either Multi-spectral Scanner (MSS) or Thematic Mapper (TM) data for measuring changes in surface water radiance and reflectance as it is related to suspended sediments and chlorophylls in surface water. A comparison of six con-current Landsat MSS and TM scenes of Moon Lake was made to determine the relationship of Lake was made to determine the relationship of Landsat digital data with suspended sediments, chlorophyll, and temperature in the surface water of the lake. There were no significant differences in best correlations between MSS or TM data with surface suspended sediments. Thus, the advantage of using MSS is the ability to monitor large areas with significantly less data. TM data can be effi-ciently used to monitor smaller lakes and reser-ration. TM Band Lefelence was the only Landest ciently used to monitor smaller lakes and reservoirs. TM Band I reflectance was the only Landsat data that accounted for at least 50% of the variadata that accounted for at least 50% of the variadata that accounted for at least 50% of the variadata that accounted for the same than bility in the chlorophyll data. This would not be adequate for a monitoring program for chlorophyll in sediment-dominated, agricultural lakes, such as Moon Lake. TM thermal data were highly correlated with surface water temperature. TM-measmeet with surrace water temperature. IM-meas-ured surface water temperatures could be useful in determining water balance in small agricultural reservoirs. A monitoring program based an Land-sat MSS and TM scanners can provide data on suspended sediments that would allow the location of reservoirs with significant suspended sedin and allow better conservation assessment and planning. (Korn-PTT) W91-11354

GRAPHICAL METHOD FOR DETERMINING THE COEFFICIENT OF CONSOLIDATION CV FROM A FLOW-PUMP PERMEABILITY TEST. Geological Survey, Denver, CO. R. H. Morin, H. W. Olsen, K. R. Nelson, and J. D.

Gill. Geotechnical Testing Journal, p 302-307, December 1989. 6 fig, 17 ref.

Descriptors: \*Coefficient of consolidation, \*Con-Descriptors: "Coefficient of consolidation, "Con-solidation, "Graphical analysis, "Groundwater movement, "Permeability, "Pumping tests, "Pumps, Darcys law, Data interpretation, Ground-water mining, Hydraulic head, Infusion, Mathe-matical studies, Porous media.

A graphical method has been developed for deter-A graphical method has been developed to deter-mining the coefficient of consolidation from the transient phases of a flow pump permeability test. The flow pump can be used to infuse fluid into or withdraw fluid from a laboratory sediment speci-men at a constant volumetric rate in order to obtain data that can be used to calculate permeability using Darcy's law. When the initial transient-response curve (hydraulic head as a function of time) generated by this test is examined analytically in terms of a one-dimensional consolidation ly in terms of a one-dimensional consolidation process, representative type curve solutions to the associated forced flow and pressure decay models are derived. These curves provide the basis for graphically evaluating the permeability, k, the coefficient of consolidation c, and the coefficient of volume change, m. The curve matching technique is easy and rapid, and it can be applied to results of forced flow tests, both infusion and withdrawal, as well as to subsequent pressure decay records. Values of k, c, and m, for a laterally confined

kaolinite specimen were determined by this graphikaolinite specimen were determined by this graphical method and appear to be in reasonably good agreement with numerically derived estimates (within 20%). Discrepancies between the two sets of results seem to be largely a function of data quality rather than of method of analysis. Where responses of hydraulic head as a function of time are apparently unaffected by experimental sources of error, agreement is excellent (within 4%). Application of this graphical method to triaxial testing has inherent uncertainties, because the solution curves that describe one-dimensional deformation are used to analyze a three-dimensional process. (Author's abstract)

DENDROGEOMORPHIC APPROACH TO ESTIMATING SLOPE RETREAT, MAXEY FLATS,

KENTUCKY.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 2D.
W91-11395

REFINEMENT OF THE COMBINATION EQUATIONS FOR EVAPORATION.

National Oceanic and Atmospheric Administra-tion, Princeton, NJ. Geophysical Fluid Dynamics Lah

For primary bibliographic entry see Field 2K. W91-11398

APPLICATION OF UPHOLE DATA FROM PETROLEUM SEISMIC SURVEYS TO GROUNDWATER INVESTIGATIONS, ABU UNITED ARAB EMIRATES).
Geological Survey, Tacoma, WA.
D. Woodward, and C. M. Menges.
Geoexploration GEOXAV, Vol. 27, p 193-212, 1991. 9 fig, 23 ref.

Descriptors: \*Borehole geophysics, \*Data inter-\*Geohydrology, \*Geophysics,

"Geophysics, "Data Interpretation, "Geophysics, "Groundwater resources, "Seismic surveys, "United Arab Emirates, Flow velocity, Groundwater movement, Maps, Oil industry, Surveys, Water table.

Velocity data from uphole surveys were used to map the water table and the contact at the base dune sand/top alluvium in the Emirate of Abu Dhabi. During 1981-83, a reconnaissance seismic survey was conducted for petroleum exploration in Survey was conducted for petroleum exploration in the eastern region of Abu Dhabi. Approximately 2800 km of seismic data, consisting of 92 lines, were acquired in the 2500 sq km concession area were acquired in the 2500 sq km concession area and Ain. Uphole surveys were conducted about 2 km apart along each seismic line, and were used to calculate weathering corrections required to further process in the seismic data. Approximately 1300 uphole surveys were completed in the concession area between March 1981 and June 1983. Reinterpretation of the velocity profiles derived from the uphole surveys provided data for determining the following subsurface layers, listed in descending order: (1) a surficial, unconsolidated weathering layer with a velocity from 300 to 450 m/s; (2) surficial sand, from 750 to 900 m/s; (3) unsaturated, unconsolidated alluvium, from 1000 to un/s; (2) surficial sand, from 750 to 900 m/s; (3) unsaturated, unconsolidated alluvium, from 1000 to 1300 m/s; and (4) saturated, unconsolidated alluvium, from 1900 to 2200 m/s. Two interfaces—the water table and the base dune sand/son alluvium. um, from 1900 to 2000 m/s. Two internaces—the water table and the base dune sand/top alluvium—were identified and mapped from boundaries between these velocity layers. Although the regional water table can fluctuate naturally as much as 3 m/ water table can fluctuate naturally as much as 3 m/y rin this area, an extremely consistent and interpretable water table map was derived from the uphole data throughout the entire concession area. In the northern part of the area, unconfined groundwater moves northward and northewstward toward the Arabian Gulf; and in the central and southern parts of the area, groundwater moves westward away from the Oman Mountains. In the extreme southern area east of Jable Hafti groundwater moves southward into Omale Haffi, groundwater moves southward into Oman. The map of the base dune sand/top alluvium sug-gests a buried paleodrainage network trending westward to southwestward away from the Oman Mountains. These paleodrainages, now buried by dune sand, probably contain alluvial fill and are logical targets for groundwater exploration. (AuW91-11399

USEFULNESS OF VARIOUS NUMERICAL METHODS FOR ASSESSING THE SPECIFIC EFFECTS OF POLLUTION ON AQUATIC

Hamburg Univ. (Germany, F.R.). Inst. fuer Hydrobiologie und Fischereiwissenschaft.

For primary bibliographic entry see Field 5C. W91-11406

EFFECT OF DECOUPLED LOW-LEVEL FLOW ON WINTER OROGRAPHIC CLOUDS AND PRECIPITATION IN THE YAMPA RIVER VALLEY.

Colorado State Univ., Fort Collins. Dept. of At-

mospheric Science. For primary bibliographic entry see Field 2B. W91-11410

PERSISTENT PATTERNS OF THUNDERSTORM ACTIVITY IN THE CENTRAL UNITED STATES.

Indiana Univ. at Bloomington. Dept. of Geography. For primary bibliographic entry see Field 2B.

SOIL MOISTURE: EMPIRICAL DATA AND MODEL RESULTS.

Gosudarstvennyi Gidrologicheskii Inst., Leningrad (USSR). nary bibliographic entry see Field 2G.

SPATIAL DISTRIBUTION OF PRECIPITA-TION SEASONALITY IN THE UNITED STATES.

Environmental Protection Agency, Research Tri-angle Park, NC. Atmospheric Research and Expo-sure Assessment Lab.

For primary bibliographic entry see Field 2B. W91-11414

FOUR-PARAMETER MODEL FOR THE ESTI-MATION OF RAINFALL FREQUENCY SOUTH-WEST ENGLAND. For primary bibliographic entry see Field 2B. W91-11415

NUMERICAL SIMULATIONS OF THE EVO-LUTION OF A COLD FRONT AND ITS PRE-CIPITATION.

Illinois Univ., Urbana. Lab. for Atmospheric Research. nary bibliographic entry see Field 2B. For primar W91-11418

SENSITIVITY STUDIES OF TROPICAL STORM GENESIS USING A NUMERICAL

National Oceanic and Atmospheric Administra-tion, Princeton, NJ. Geophysical Fluid Dynamics

For primary bibliographic entry see Field 2B. W91-11421

ESTIMATING FLOW CHARACTERISTICS AT UNGAUGED SITES. Geological Survey, Reston, VA. For primary bibliographic entry see Field 2E. W91-11545

ANALYSIS AND INTERPRETATION OF THE BOREHOLE TELEVIEWER LOG: INFORMA-TION ON THE STATE OF STRESS AND THE LITHOSTRATIGRAPHY AT HOLE 504B.

Geological Survey, Denver, CO. R. H. Morin, R. N. Anderson, and C. A. Barton. Proceedings of the Ocean Drilling Program, Scien-tific Results, Vol. 111, 1989. p 109-118, 11 fig, 48

#### Field 7—RESOURCES DATA

# Group 7C—Evaluation, Processing and Publication

Descriptors: \*Data interpretation, \*Boreholes, \*Logging (recording), \*Lithostratigraphy, Oceans, Lava, Ocean bottom, Acoustics, Physical properties, Stress.

Hole 504B in the eastern equatorial Pacific has been the focus of several scientific expeditions during the past few years, where a series of re-entry, drilling, and coring operations has yielded important data regarding the structure of the upper kilometer of the oceanic lithosphere. As part of the extensive downhole experiments program planned for ODP Leg 111 at this site, a borehole televiewer (BHTV) log was obtained across a 355-m vertical section of crustal basement, extending upward from 1531 to 1176 m below the sea floor. The BHTV record was analyzed in terms of both acoustic amplitude and traveltime in order to accurately identify zones of structural failure in the surrounding basement rock. A subsequent examination of breakout frequency vs. azimuth helped identify the orientation of in-situ horizontal principal stresses according to the well substantiated hypothesis that breakouts occur coincident with the direction of minimum principal stress (Sh) where compressive forces are at their greatest. The distribution of breakout frequency vs. azimuth shows the data to be bimodal and orthogonal to a degree that is statistically significant. The Sh directions of the compressive forces are at their greatest. tion is inferred from the primary mode. The or-thogonal pattern indicates that a considerable number of wellbore enlargements were detected coincident with the direction of maximum princi-pal stress (SH). These are interpreted as extension-al fractures produced by localized tensional al fractures produced by localized tensional stresses parallel with the SH orientation. Consideration of various hydraulic fracturing schemes and attendant analyses indicates that these fractures are likely to be induced when the ratio of effective horizontal principal stresses (SH/Sh) is very large in a cylindrical wellborer or is somewhat smaller in a hole exhibiting a slight degree of ellipticity. Inspection of three-dimensional images generated from the BHTV record in the lower portion of the borehole reveals the surprising appearance of pillow lavas at a depth previously assumed to be composed of sheeted dikes. When the ophiolite analogy is applied to contemporary oceanic crust, the transitional unit between the upper pillow lavas and minor flows and the variably metamorphosed and minor hows and the variatist internation prosect diabase dikes below seems to be a complex, gradu-al, and gradational inter-layering of lithologies that extends over a thicker vertical interval than previ-ously thought. (Author's abstract) W91-11549

INTERPRETATION OF HYDROLOGIC EFFECTS OF CLIMATE CHANGE IN THE SACRAMENTO-SAN JOAQUIN RIVER BASIN, CALIFORNIA.

Washington Univ., Seattle. Dept. of Civil Engineering. For primary bibliographic entry see Field 5C. W91-11552

GEOLOGIC FRAMEWORK OF THE COLUMBIA PLATEAU AQUIFER SYSTEM, WASH-INGTON, OREGON, AND IDAHO.
Geological Survey, Portland, OR. Water Re-

For primary bibliographic entry see Field 2F. W91-11571

DELINEATION OF FLOODING WITHIN THE OZARK NATIONAL SCENIC RIVERWAYS IN SOUTHEASTERN MISSOURI-AKERS AND ALLEY SPRING.

Geological Survey, Rolla, MO. Water Resources Div.

For primary bibliographic entry see Field 2E. W91-11578

DELINEATION OF FLOODING WITHIN THE OZARK NATIONAL SCENIC RIVERWAYS IN SOUTHEASTERN MISSOURI-ROUND SPRING AND POWDER MILL.

Geological Survey, Rolla, MO. Water Resources Div.

For primary bibliographic entry see Field 2E.

W91-11579

POTENTIAL FOR AQUIFER RECHARGE IN ILLINOIS (APPROPRIATE RECHARGE AREAS).

AREAS).
Illinois State Geological Survey Div., Champaign.
D. A. Keefer, and R. C. Berg.
Illinois State Geological Survey, 1990. 1p, 3 fig, 10
ref.

Descriptors: \*Aquifers, \*Artificial recharge, \*Groundwater recharge, \*Illinois, \*Maps, \*Recharge, Bedrock aquifers, Data interpretation, Geohydrology, Groundwater resources, Hydrologic data collections, Infiltration.

The Illinois Groundwater Protection Act has specified that areas of appropriate recharge be identified as part of the State's effort to assess the groundwater resources of Illinois (P.A. 85-863, Section 7.(b)(2)). Appropriate recharge areas, undefined by the Act, have been defined by the Illinois State Geological Survey on a regional basis as the relative potential for recharge to underlying aquifers. This map combines information regarding the distribution, thickness, texture, and hydraulic conductivity of mapped sequences of shallow geologic materials; the distribution of major sand and gravel aquifers; the distribution of major sand and gravel aquifers; the distribution of major bedrock aquifers within 91.2 m (300 ft) of ground surface; and the regional variability of potential for infiltration throughout the state. Combining this geohydrologic information makes it possible to estimate the relative potential for water, available at ground surface as precipitation, to infiltrate the soil surface and percolate down to the uppermost aquifer. The recharge map was produced using a computerized geographic information system to compile, combine, and interpret four statewide map databases: stack-unit map of Illinois; major sand and gravel aquifers; major bedrock aquifers within 300 ft of ground surface; and general soil map of Illinois. This map is a screening tool, designed for regional evaluations of the relative potential for recharge to aquifers. It can also be used to evaluate the vulnerability of aquifers to surficial sources of contamination and to identify regions potentially suitable for sting surficial waste storage or disposal facilities. Constraints of scale and data required the generalization and extrapolation of geologic and soils information. Thus, this map is not accurate enough to be used for site-specific purposes. Selection of specific sites for surficial waste storage or disposal facilities requires detailed geologic mapping and geohydrologic evaluation. (Lantz-PTT)

POINT-INFILTRATION MODEL FOR ESTI-MATING RUNOFF FROM RAINFALL ON SMALL BASINS IN SEMIARID AREAS OF WYOMING.

For primary bibliographic entry see Field 2E. W91-11585

TRENDS IN WATER-QUALITY DATA IN TEXAS,
Geological Survey, Austin, TX. Water Resources

Div. For primary bibliographic entry see Field 5B. W91-11593

#### 8. ENGINEERING WORKS

#### 8A. Structures

BOSTON'S SEWAGE OUTFALL. For primary bibliographic entry see Field 5D. W91-10485

DALLAS' FLOOD CAVERNS.
J. W. Hefner, T. P. Kwiatkowski, and D. O.

Brock.
Civil Engineering (ASCE) CEWRA9, Vol. 61,
No. 3, p 79-81, 1991. 2 fig.

Descriptors: \*Flood control, \*Flood routing, \*Flood-control storage, \*Highways, \*Texas, Con-

struction costs, Construction methods, Dallas, Floodwater, Road construction, Structure, Tunnel construction, Tunnels.

Artificial caverns of unprecedented size will solve Dallas Highway's flooding problem. Normally, underground detention chambers would cost too much, but site conditions are right. With low-strength bedrock to cut through and an existing drainage tunnel as the project's starting point, the cavern will save the city over \$4 million. The detention caverns are among many modifications being made to the North Central Expressway (U.S. 75). The road, one of the major north-south free-ways connecting the city's central business district with north Dallas and its northern suburbs, has become overburdened with traffic after many years of development along the corridor. In addition to the caverns, drainage improvements include tunnels under North Central Expressway between Woodall Rodgers Freeway and University Boulevard. Construction of the \$28 million caverns began in April 1990 and is scheduled to be complete in the fall of 1993. The caverns will have a total volume of 71 million gallons. A 40 foot high by 24 foot wide (maximum) vault with curved walls and 16 foot thick pillars was selected as the most workable design based on stress flows around the opening and the maximum and average stresses in the pillar. Patterned, fully resin-encapsulated rock dowels will support the vault at the crown, reinforcing the existing rock above to ensure the formation of a self-supporting rock aroth. Patterned, fully encapsulated rock botts will prevent loosening of the rock in the pillars. Double-position borehole extensometers may measure displacements in the detention vault tunnels. Convergence reference points, in addition to those shown on the fawnings, are also specified for this purpose. (Mertz-PTT)

MELVIN PRICE LOCKS AND DAM AUXILIA-RY LOCK AND ROTARY LOCK CULVERT VALVE, MISSISSIPPI RIVER, ALTON, ILLI-NOIS: HYDRAULIC MODEL INVESTIGA-TION.

Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab. For primary bibliographic entry see Field 8C. W91-10723

NONLINEAR EARTHQUAKE RESPONSE OF CONCRETE GRAVITY DAM SYSTEMS. California Inst. of Tech., Pasadena. For primary bibliographic entry see Field 8F.

For primary bibliographic entry see Field 8F. W91-10754

ANALYSIS OF THREE-DIMENSIONAL GROUND MOVEMENTS: THE THUNDER BAY TUNNEL.

University of Western Ontario, London. Geotechnical Research Centre.

K. M. Lee, and R. K. Rowe. Canadian Geotechnical Journal CGJOAH, Vol. 28, No. 1, p 25-41, February 1991. 17 fig. 2 tab, 30 ref. Geotechnical Research Center Grant No. A1007.

Descriptors: \*Finite element method, \*Model studies, \*Ontario, \*Soil mechanics, \*Tunnel construction, \*Tunneling, Clays, Deformation, Elastic properties, Ground deformations, Plasticity, Soil properties, Stress analysis, Thunder Bay Tunnel.

A three-dimensional (3D) elastoplastic finite-element analysis, which is capable of simulating the dayonace of a tunneling shield and the associated ground losses resulting from the tunneling process, is used to calculate the deformation caused by the excavation of the Thunder Bay sewer tunnel. The soil parameters adopted in the analysis were based on the results determined from stress-dependent triaxial tests. The results of this analysis were then compared with the measured soil displacements. Reasonable agreement was found to exist between the calculated and observed 3D settlement distribution and horizontal displacements at different distances from the tunnel face. This overall agree-

# **ENGINEERING WORKS—Field 8**

# Structures—Group 8A

ment for displacements under 3D conditions suggests that the method of analysis may be applicable to design problems involving tunneling in soft clays similar to that at the Thunder Bay sewer tunnel provided that the soil parameters are reliably determined. (Author's abstract) W91-10775

ANALYSIS OF A SANITARY-EMBANKMENT FAILURE OVER THE RIO DE JANEIRO SOFT CLAY DEPOSIT.

For primary bibliographic entry see Field 8D. W91-10780

GEOTECHNICAL APPRAISAL OF THE FOUN-DATION ROCK MASS BEHAVIOUR OF NAR-MADA SAGAR DAM PROJECT, CENTRAL INDIA: A CASE STUDY. Indian School of Mines, Dhanbad. For primary bibliographic entry see Field 8E. W91-10784

DETERMINISTIC COMPUTER-AIDED OPTI-

MUM DESIGN OF ROCK RUBBLE-MOUND BREAKWATER CROSS-SECTIONS.
Department of Civil Engineering, City Management Amsterdam, Wibautstraat 3, 1091 GH, Amsterdam, The Netherlands.

W. de Haan.
Coastal Engineering COENDE, Vol. 15, No. 1/2, p 3-19, March 1991. 7 fig, 2 tab, 13 ref.

Descriptors: \*Breakwaters, \*Computer programs, \*Computer-aided design, \*Hydraulic structures, Benefits, Construction costs, Cross-sections, Economic aspects, Feasibility studies, Maintenance costs, Optimization, Performance evaluation, Quarries, Stability analysis, Wave height.

Due to the unique nature of hydraulic structures, Due to the unique nature of hydraulic structures, such as breakwaters, it is difficult to use a computer in their design. A study was undertaken in which the computation of the economic optimum rubble-mound breakwater cross-section was executed on a microcomputer. The Rubble Mound Breakwater (RUMBA) computer package was used to compute the optimum rubble-mound breakwater cross-section by minimizing the sum of construction costs and maintenance costs over the lifetime of the structure. In addition, computer aided design (CAD) software was applied in the lifetime of the structure. In audition, computer aided design (CAD) software was applied in the optimization process. Optimization requires a balance between functional effectiveness (benefits) and structural costs, consisting of construction costs and maintenance costs. The quarry production of the cost cosis and maintenance costs. The quarry produc-tion, divided into a number of categories, and long-term distributions of deep water wave heights and water levels, form the basis of the computation. Deep water wave heights are converted to wave heights at site. A set of alternative cross-sections is computed based on both functional performance criteria, and Van der Meer's stability formulae for statistically stable structures. Construction costs statistically stable structures. Construction costs and maintenance costs are determined for each alternative. The optimum is derived by minimizing alternative. The optimum is derived by minimizing the sum of the construction costs and maintenance costs. Moreover, the program provides means to economize the use of the quarry. The computer program proved to be useful in feasibility studies of harbor protection or coastal protection in regions where use can be made of a quarry in the neighborhood of the project site. (Korn-PTT) W91-10785

ROCKING ARMOUR UNITS: NUMBER, LOCA-TION AND IMPACT VELOCITY. Waterloopkundig Lab. te Delft (Netherlands). J. W. van der Meer, and G. Heydra. Coastal Engineering COENDE, Vol. 15, No. 1/2, p 21-39, March 1991. 14 fig, 1 tab, 6 ref.

Descriptors: \*Breakwaters, \*Coastal engineering, \*Concretes, \*Hydraulic structures, Data processing, Mathematical studies, Model studies, Prediction, Stability analysis, Strength, Wave height, Wave velocity

During the late seventies and early eighties several breakwaters were severely damaged along the

coast of the European and African countries in the coast of the European and African countries in the Mediterranean and the Atlantic Ocean. The armour layers of these structures consisted of large concrete units weighing between 20 and 60 tons. These units had a slender shape and were made of unreinforced concrete. A research project was undertaken to investigate the strength of concrete armour units by performing model tests on break-water sections armoured with Cubes and Tetrawater sections armoured with Cubes and retra-pods. Stability tests resulted in a prediction of the number of moved units and the number of impacts as a function of wave height, period and location on the slope. Measurements on acceleration during on the slope. Measurements on acceleration during impacts resulted in a description of the distribution of impact velocities at the center of the unit. These distributions were described by an exponential function with a threshold level and were dependent on the type of unit, the location of the unit on the slope and the wave height. The expressions are applicable in prototype conditions. (Korn-PTT) W91-10786

SEISMIC FRACTURE ANALYSIS OF CON-CRETE GRAVITY DAMS.

Concordia Univ., Loyola Campus, Montreal (Quebec), Dept. of Civil Engineering. For primary bibliographic entry see Field 8F. W91-10787

PRESSURE OF CLAY BACKFILL AGAINST RETAINING STRUCTURES.
Surrey Univ., Guildford (England). Dept. of Civil

Engineering.
For primary bibliographic entry see Field 8D.
W91-10947

SEISMIC HAZARD AT NARMADA SAGAR

National Geophysical Research Inst., Hyderabad For primary bibliographic entry see Field 8E. W91-10949

DEVELOPMENT OF SMALL HYDRO FOR REMOTE AREAS OF NORTHERN PAKISTAN. Northern Areas Public Works Dept., Gilgit (Paki-

For primary bibliographic entry see Field 8C. W91-11215

SOCIO-POLITICAL ASPECTS OF THE BOS-NAGYMAROS BARRAGE SYSTEM. Regional Environmental Centre, Budapest (Hun-

gary). For primary bibliographic entry see Field 6G. W91-11217

HYDRAULICKING IN ENVIRONMENTAL PROTECTION AND RESTORATION. For primary bibliographic entry see Field 5G. W91-11283

METHOD OF CALCULATING THE TECHNO-LOGICAL PARAMETERS WHEN DESIGNING HYDRAULIC-FILL DAMS OF SILTY SOILS.

E. L. Vvedenskii. Hydrotechnical Construction HYCOAR, Vol. 24, No. 6, p 354-362, December 1991. 4 fig, 3 tab, 6 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, pp. 5-9, June, 1990.

Descriptors: \*Dam construction. \*Earth dams, Hydraulic fill, \*Soviet Union, Civil engineering, Dam foundations, Design criteria, Hydraulic engineering, Materials engineering, Soils.

There are several advantages associated with constructing a dam by the hydraulic-fill method using local materials. This practice has been used extensively in the Soviet Union in the construction of sively in the Soviet binoin in the constitution of large and medium power and irrigation dams. However, difficulties arise when hydraulic filling of structures is done using fine-grained silty and loess-like soils because of some of their hydrophysical properties. An investigation was conducted of the properties of these soils during settlement and

seepage consolidation, when the physical and n chanical indices of the silty soils may not be suffi-cient for stability of the profile structure. This work demonstrated that, when constructing dams work demonstrated that, when constructing dams of fine-grained silty soils by hydraulic filling, it is expedient to use the technology of layerwise placement of soil with consolidation of each layer. Equations have been developed for calculating the thicknesses of the layers and the period of consolidation of the soil that is needed based on investigations of hydrophysical dynamics of these soils. Equations also have been proposed for predicting the density of hydraulic-filled soil during construction and the distribution of soil in the profile of the the density of hydraulic-filled soil during construc-tion and the distribution of soil in the profile of the structure. A method was developed for calculating technological parameters, particularly the rate of construction of hydraulic-fill structures, calcular-ing the size and number of hydraulic-fill plots associated with one dredge, and predicting seepage discharge into the foundation of dams during their hydraulic filling. (Rochester-PTT) W91-11284

ASSIGNMENT OF THE CLASS OF HYDRAU-LIC-FILL WASTE DUMPS.

For primary bibliographic entry see Field 5E. W91-11285

CHARACTERISTICS OF MINING OUARRIES ON HYDRAULIC-FILL DUMPS.

V. G. Panteleev, A. V. Bodrova, and G. A.

Hydrotechnical Construction HYCOAR, Vol. 24, No. 6, 9 370-372, December 1991. 1 fig, 3 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, pp. 14-15, June, 1990.

Descriptors: \*Hydraulic fill, \*Land reclamation, \*Mining engineering, Classification, Quarries, Safety, Slope stability.

In the Soviet Union and elsewhere there are sever-al thousand hydraulic-fill dumps, including ash dumps, tailings dumps, slag dumps, and other types, containing billions of cubic meters of pro-duction wastes. It may be duction wastes. It may become necessary to quarry these dumps, either to obtain the wastes for reprocessing or as part of land restoration efforts. A classification and characterization of the quarries that may be developed on these sites was conducted with the aim of calculating the stability of their slopes in order to increase the safety of working on hydraulic-fill dumps. Three types of quarries are recognized: (1) one that is mined from the side, so that the water level of the quarry is always below the hottom: (2) one that is mined from the bottom: that the water level of the quarry is always below its bottom; (2) one that is mined from the bottom; and (3) wastes are excavated from the side of a quarry filled with the water. Types 1 and 2 are applicable to self-compacted dumps, whereas type 3 is most characteristics of hydraulic-fill dumps. s most characteristics of hydraulic-fill dumps. The mining technology employed differs according to the type of dump being mined. Calculation methods have been developed, one for each type of quarry, for determining the appropriate steepness of quarry slopes to provide adequate safety. (Rochester-PTT) W91-11286

OPERATING EXPERIENCE AND SUGGES-TIONS ON RECONSTRUCTION OF THE TUR-BINES OF THE DNEPR-I HYDROELECTRIC STATION.

For primary bibliographic entry see Field 8C. W91-11290

FIRST STEPS TOWARD INCREASING THE RELIABILITY OF HYDROPOWER AND WATER-MANAGEMENT FACILITIES.

N. I. Khrisanov.

No. 6, p 402-404, December 1991. 11 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, pp. 33-34, June, 1990.

Descriptors: \*Design standards, \*Management planning, \*Project planning, \*Public participation, \*Reliability, \*Soviet Union, Environmental protec-

#### Field 8-ENGINEERING WORKS

# **Group 8A—Structures**

tion, Feasibility studies, Hydroelectric plants, Prediction, Reservoirs, Water management.

diction, Reservoirs, Water management.

As the Soviet Union changes socially in response to 'perestroika,' great emphasis is being placed on improved quality and reliability in large economic facilities such as hydropower plants. Emphasis is shifting from purely engineering concerns to social and ecological concerns as part of the justification for such projects. The planning of many hydropower and water management facilities has become frozen at the feasibility stage as a results of public concern over ecological and sometimes social unreliability of these facilities. Steps that could be taken to improve the planning process include: (1) broad glasnost (openness) and publicity about a proposed facility and planned construction; (2) the wide use of naturalists (ecologists, biologists, climatologists, botanists, ichthyologists, etc.) for solving corresponding problems at the feasibility and design stages; (3) change in the composition and structure of design documents to include a section on "Environmental Protection"; (4) changing from an exclusively economic assessment of projects to one that incorporates assessment of the use of natural resources and payment for their use and pollution; (5) consideration of alternative veruse of natural resources and payment for their use and pollution; (5) consideration of alternative versions of hydropower and water management schemes; and (6) the immediate development of standard reference documents for ecological forecasts, substantiation, and provision of ecological reliability. (Rochester-PTT) W91-11291

DISTRIBUTION AND MIGRATION OF HEAVY METALS IN THE ENVIRONMENT OF THE ALTAI MOUNTAINS IN CONNECTION WITH ECOLOGICAL SUBSTANTIATION OF KATUN HYDROELECTRIC STATION

For primary bibliographic entry see Field 5B. W91-11292

ABBEYSTEAD OUTFALL WORKS: BACK-GROUND TO REPAIRS AND MODIFICA-TIONS AND LESSONS LEARNED.

For primary bibliographic entry see Field 5D. W91-11355

BECK FLOOD-ALLEVIATION

SCHEME.
Babtie Dobbi, Consulting Engineers, Croydon, Surrey, England. J. D. Winders.

Journal of the Institution of Water and Environ-mental Management JIWMEZ, Vol. 5, No. 1, p 85-90, February 1991. 4 fig, 1 tab, 4 ref.

Descriptors: \*Channel improvement, \*England, \*Flood control, \*Floodproofing, Dams, Floodways, Model studies, Reservoirs, Spillways.

detention and channel improvement schemes for the Fenay Beck, a main tributary of the Colne River of West Yorkshire, have been designed to alleviate the flooding of domestic and industrial properties to a 50-yr standard of protection. Landscape architects were incorporated into the design teams to cover environmental aspects of the project. A flood-detention dam was constructand project. A food-detenment and was construct-ed mainly of colliery waste. The design of the concrete horseshoe spillway and stilling basin was checked using a 1:40 physical model. The river level would be regulated by an automatic vertical gate activated by downstream water levels. Fol-lowing refusal of the initial plan, a channel-im-provement scheme was adopted. Reduction in valley storage increased downstream flows necessi-tating the enlargement of an old brick and concrete culvert within the ICI works to ensure that there were no detrimental effects within their boundary. An increased benefit/cost ratio of 3.46 as com-pared with 2.55 obtained for the detention scheme was partly due to the application of new standards.
(Author's abstract)
W91-11365

PHOTOGRAPHS WRITTEN HISTORICAL AND DESCRIPTIVE DATA.

National Park Service, San Francisco, CA. Western Region.

For primary bibliographic entry see Field 6E.

#### 8B. Hydraulics

MATHEMATICAL MODELLING FOR RESERVOIR WATER-QUALITY MANAGEMENT THROUGH HYDRAULIC STRUCTURES: A

ENGE-RIO, Engenharia e Constuloria S.A., Rio de Janeiro (Brazil).

For primary bibliographic entry see Field 5G. W91-10490

SCOUR AT CANTILEVERED PIPE OUTLETS, PLUNGE, POOL ENERGY DISSIPATOR DESIGN CRITERIA.

Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.

W. Blaisdell, and C. L. Anderson. Available from the National Technical Information Service, Springfield, VA 22161, as PB90-133943. Price codes: A09 in paper copy, A01 in microfiche. Report No. ARS-76, October 1989. 171p, 11 fig. 13

Descriptors: \*Design standards, \*Energy, \*Experimental design, \*Hydraulic design, \*Pipes, \*Scour, \*Spillways, Culverts, Data interpretation, Engineering, Hydraulics, Literature review, Mathematical equations, Mathematical studies, Riprap.

Cantilevered pipe spillway outlets are used at most farm-pond and many upstream flood control principal spillways. Allowing pipe spillways to scour their own energy dissipation pools may be acceptable for small farm ponds. An extensive literature review on the general principles of local scour at pipe outlets revealed little practical information on scour and prevention of scour at culvert outlets. scour and prevention of scour at culvert outletsthere was no specific information on the design of plunge pool energy dissipators for pipe spillways. Equations and procedures for the design of cantile-vered pipe spillway plunge pool energy dissipators resulted from a detailed analysis of experimental data. Procedures are presented which, with a moderate degree of conservatism, can be used to deter-mine the size, shape, location, and riprap to be used for stable cantilevered pipe outlet plunge pool energy dissipators. (Lantz-PTT)
W91-10722

IN-FLOW VIBRATIONS OF GATE EDGES.

Waterloopkundig Lab. te Delft (Netherlands). T. H. G. Jongeling. Available from the National Technical Information Service, Springfield, VA 22161, as PB90-134057. Price codes: A03 in paper copy, A01 in microfiche. Report No. PUB-392, December 1988. 8p, 8 fig.

Descriptors: \*Gates, \*Hydraulic models, \*Model studies, \*Vibrations, Data acquisition, Hydraulic equipment, Hydraulic structure

A single oscillator-type hydraulic model of a gate, consisting of a vertical, 20 mm thick, stiff plate with flow underneath, was tested. This gate model had one rotational degree of freedom around a nad one rotational degree of freedom around a horizontal axis, resulting in approximately horizontal movements of the gate edge above a flat bottom. The test program covered gate openings between 5 and 50 mm. With the help of an adjustable leaf spring the natural frequency of the gate model was varied between 5.4 and 86.3 Hz (in air). A force meter was fitted between the leaf spring. A force meter was fitted between the leaf spring. and a stiff frame, to measure the response of the gate model. Numerous inflow vibrations were regate model. Numerous inflow vibrations were re-corded with a rectangular cross-sectioned gate edge. The vibrations appeared to occur in three distinct vibration domains, each characterized by a distinct range of the dimensionless reduced veloci-ty number. Vibrations in another domain, defined by a lower reduced velocity number, were an order of magnitude weaker, and occurred at small-er gate openings. (Author's abstract) W91-10724

THERMAL-PULSE FLOWMETER FOR MEAS-HOLES.

Geological Survey, Denver, CO. For primary bibliographic entry see Field 8G. W91-10766

ANALYSIS OF LARGE SCALE WATER DIS-TRIBUTION SYSTEMS.

Akron Univ., OH. Dept. of Civil Engineering. For primary bibliographic entry see Field 5F.

OPEN CHANNEL VELOCITY PROFILES OVER A ZONE OF RAPID INFILTRATION. Aberdeen Univ. (Scotland). Dept. of Engineering. A. G. Maclean.

Journal of Hydraulic Research JHYRAF, Vol. 29, No. 1, p 15-27, 1991. 5 fig, 1 tab, 8 ref.

Descriptors: \*Bed load, \*Flow models, \*Hydraulic regineering, \*Infiltration, \*Intakes, \*Open-channel flow, \*Sedimentation, \*Shear stress, \*Surface-groundwater relations, Boundary layers, Boundary processes, Flow velocity, Physical models, Shear

The design of a bed-type river intake requires serious consideration of its effect on the movement of bedload in the suction zone. The accurate esti-mation of the boundary shear stress depends on a mation of the boundary shear stress depends on a knowledge of the flow structure over the suction zone. Laboratory measurements have been made of the modification of the velocity profile in an open channel caused by a region of rapid infiltra-tion through the bed, such as that associated with a bed-type river intake. The results have been ana-lyzed to provide an estimate of bed shear stress in the suction zone. The measurements were obtained using Laser-Doppler anemometry, and were com-pared with hot-wire measurements over a similar pared with hot-wire measurements over a similar zone of suction in a wind tunnel. It was concluded zone of suction in a wind tunnel. It was concluded that the flow structure over a zone of rapid infiltration in an open channel is an inner boundary layer across which the shear stress changes rapidly, above which is a logarithmic region in which the flow structure is effectively unaltered by the presence of suction. The velocity gradient in the logarithmic region decreases as the abstraction velocity increases. The increase in shear stress at the bed caused by suction is best evaluated by considering the ratio of velocities with and without suction at a caused by suction is best evaluated by considering the ratio of velocities with and without suction at a reference height close to the bed. A height of 2 mm was found to match the available data most closely in this case. (Fish-PTT) W91-10984

DRAG ON VERTICAL SILL OF FORCED JUMP.

Nihon Univ., Tokyo. Dept. of Civil Engineering. I. Ohtsu, Y. Yasuda, and Y. Yamanaka. Journal of Hydraulic Research JHYRAF, Vol. 29, No. 1, p 29-47, 1991. 24 fig, 1 tab, 12 ref.

Descriptors: \*Drag, \*Energy dissipation, \*Hydrau-lic engineering, \*Hydraulic jump, \*Spillways, \*Water pressure, Flow characteristics, Flow equa-tions, Hydraulic design, Hydraulic structures, Hy-drostatic pressure, Pressure distribution.

To dissipate the energy of a high-speed discharge flowing down a spillway, it is common to use a hydraulic-jump-type energy dissipator. As a basis for designing a forced hydraulic-jump-type stilling basin, the pressure magnitude on the upstream and downstream faces of a continuous-vertical sill has been investigated experimentally, and the nature of the pressure distribution on the faces of the sill has been examined. The flow conditions of the stream passing over the continuous-vertical sill are classified as Type I jump (the flow condition upstream of the sill is influenced by the downstream depth), Type II jump (the upstream flow is not influenced by the downstream depth), and Spray condition (the supercritical flow impinges directly on the sill and splashes without forming a jump). An experimental formula for the drag force acting on the sill has been proposed considering the characteristics of the flow condition over the sill, which makes it passing over the continuous-vertical sill are classi-

#### ENGINEERING WORKS—Field 8

# Hydraulic Machinery—Group 8C

possible to calculate the total pressure on the upstream face of the continuous-vertical sill. For Type I and II jumps and Spray condition, the distribution of the dynamic pressure acting on the upstream face of the sill takes an S-shaped pattern, caused by the triangular eddy formed immediately before the sill. In the case of unventilated conditions behind the sill, the pressure acting on the downstream face of the sill is smaller than the hydrostatic pressure and shows a linear distribution pattern. (Fish-PTT) possible to calculate the total pressure on the up-

SURFACE DILUTION OF ROUND SUB-MERGED BUOYANT JETS.

Michigan Univ., Ann Arbor. Dept. of Civil Engineering. For primary bibliographic entry see Field 5E. W91-10986

SIMILARITY SOLUTIONS OF THE SHALLOW

WATER EQUATIONS.
Reading Univ. (England). Dept. of Mathematics.
P. Glaister.

Journal of Hydraulic Research JHYRAF, Vol. 29, No. 1, p 107-116, 1991. 6 fig, 1 ref.

Descriptors: \*Flow equations, \*Hydraulic engineering, \*Mathematical studies, \*Numerical analysis, \*Open-channel flow, \*Shallow water equations, \*St Venant equation, Channel flow, Model testing, Prediction, Shallow water, Shock waves.

An important aspect of numerical schemes is to be able to check their predictions against suitable test problems, preferably ones for which an exact solution is available. A one-dimensional problem of shock (bore) reflection was examined for the two-dimensional problems of the control of the two-dimensional problems. shock (bore) reflection was examined for the two-dimensional shallow water equations with cylindri-cal symmetry in order to derive an exact similarity solution. The nonlinear shallow water (St Venant) equations govern the flow of water in a channel whose lower surface is flat. The shock-reflection test problem was stated in a single 'radial' coordi-nate and the differential equations for the similarity colotion were derived and solved compericults in solution were derived and solved numerically in conjunction with the Rankine-Hugoniot shock reconjunction with the Rankine-Angoinot sack re-lations. This result is particularly useful for testing the symmetry properties, accuracy, and shock-cap-turing capabilities of a code for the two-dimension-al shallow water equations. (Fish-PTT) W91-10987

GEOMORPHOLOGICAL DISPERSION. Trento Univ. (Italy). Dipt. di Ingegneria Civile e For primary bibliographic entry see Field 2E. W91-11232

CORRECTION COEFFICIENTS FOR UNI-FORM CHANNEL FLOW. Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Wasserbau,

Hydrologie und Glaziologie. For primary bibliographic entry see Field 2E. W91-11282

ROUGHNESS COEFFICIENTS OF WATER-COURSE REVETTED WITH HALF-CIRCULAR CONCRETE PIPES, RESULTS OF FIELD MEASUREMENTS IN WATERCOURSE S 333

AT MAARKEDAL.

Ministry of the Flemish Community, Administration of Environmental Planning and the Environment, Working Group for Rural Water Management in the Flemish Region, Merelbeke, Belgium.

M. Voet, and W. Diericks.

Agricultural Water Management AWMADF, Vol. 19, No. 1, p 17-26, January 1991. 1 tab, 7 fig,3 ref.

Descriptors: \*Belgium, \*Concrete pipes, \*Erosion control, \*Hydraulic roughness, \*Open-channel flow, \*Roughness coefficient, Flow profiles, Flow velocity, Surface water.

Watercourse S 333 at Maarkedal (Belgium) drains a hilly area. The use of concrete pipes as revetment for smaller channels in hilly regions is a hydrauli-

cally justifed choice. Bed erosion of the watercourse is efficiently prevented even if the pipes are installed with less precision or have rather large openings between two adjacent tubes. Water openings between two adjacent tuoes. Water depths were obtained from water level recorders and a measuring weir allowed discharge determinations. Only peak values were considered to determine the roughness coefficients. Water level calculations were used without considering additional energy loss coefficients, so that all the chambel irresulted the service work of the company of cancinations were used without considering additional energy loss coefficients, so that all the channel irregularities were included in the roughness coefficients. Over nearly the whole range of flows, the roughness coefficient value decreased with increasing water depths. A value of 43 m(1/3)/s) was calculated at a depth of half the diameter of the pipe. This type of revetment proved to be an excellent protection against erosion, even in reaches with steep slopes, where the supercritical flow occurs. Flow velocities in water courses having a revetment make of half concrete pipes remain generally high as a result of the slope of the longitudinal section on the one hand and the lower wall roughness of the concrete revetment pipes compared to natural vegetation on the other hand. An important self-cleaning effect is obtained, making these watercourses practically maintenance free. A minimum pipe diameter of 80 cm is recommended to reduce the influence of an excessive bank vegetation especially during summer. (Author's abstract) W91-11431

#### 8C. Hydraulic Machinery

MELVIN PRICE LOCKS AND DAM AUXILIA-RY LOCK AND ROTARY LOCK CULVERT VALVE, MISSISSIPPI RIVER, ALTON, ILLI-NOIS: HYDRAULIC MODEL INVESTIGA-

Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab. W. G. Davis, and R. A. Davidson. Available from the National Technical Information Service, Springfield, VA 22161. Technical Report HL-91-5, March 1991. Final Report. 83p, 13 fig, 53

\*Culverts. Descriptors: \*Hydraulic models, \*Hydraulic valves, \*Melvin Price Locks, \*Mississippi River, \*Model studies, Data acquisition, Flow discharge, Hydraulics, Illinois, Spill-

Tests were conducted on a 1:30-scale model of the Tests were conducted on a 1:30-scale model of the Melvin Price Auxiliary Lock, Alton, Illinois, and on a 1:12-scale model of the rotary valve proposed for use as the filling and emptying valves. The lock model was built to study the effect of the rotary valves on the filling and emptying characteristics, the adequacy of the vertical slide gates to be used as a backup system, and the effects of flow through the adiacent spillway have on the lock discharge as a backup system, and the effects of flow through the adjacent spillway bays on the lock discharge outlets during emptying operations. Unsatisfactory flow conditions were observed during spillway discharges in the vicinity of the lock discharge outlet caused by discontinuity along the lock wall between the spillway pier and the discharge outlet. A wall was installed that streamlined the discontinuity and provided satisfactory flow conditions during spillway releases. Tests with rotary valves, when compared to a similar conventional system using reverse tainter valves, indicated significantly longer emptying times and slightly longer filling times. The rotary valve model was built to study the hydraulic forces acting on the valve and pressure fluctuations on and around the valve, and to observe conditions in the vicinity of the valve during steady-state and dynamic operating condiduring steady-state and dynamic operating condi-tions. The maximum pressure difference across the gate occurred when the valve reached between a 50% and 60% open position during an emptying operation. The maximum torque on the valve oc-curred when the valve reached a 50% open posi-tion. (Lantz-PTT) W91-10723

IN-FLOW VIBRATIONS OF GATE EDGES. Waterloopkundig Lab. te Delft (Netherlands). For primary bibliographic entry see Field 8B. W91-10724

CONVERTER APPLICATION FOR MINI HYDRO GENERATION.

A. Hutarew

International Water Power and Dam Construction IWPCDM, Vol. 43, No. 5, p 17-19, May 1991. 2

Descriptors: \*Electric converters, \*Electrical equipment, \*Hydroelectric plants, \*Inverters, Control systems, Germany, Hydraulic machinery, Hydraulic machinery, Hydraulic machinery, Hydraulic machinery, Hydraulic machinery ectric power, Performance evaluation,

Since 1983, the idea of adapting inverter units for power generation in water power stations has been considered but not implemented. The development of asynchronous drives for high-speed railroad trains led to the development of this technology and reduced prices considerably. In 1989, a converter unit was ordered for use as a generator at the Rottenburg (Germany) municipal hydroelectric plant, which is in the process of being refurbished. Inverters are static frequency converters with impressed current in a DC link and are included for speed variation of three-phase case with impressed current in a DC inix and are in-tended for speed variation of three-phase cage motors. Speed regulation is carried out by a simple control system based on adjustment by frequency setting and internal voltage control. Theoretical studies suggest that the technology will provide a wide range of efficiencies while dispensing with while range of enticiencies while dispensing with the mechanical system traditionally used to control frequency output. Ultimately, developments in converter technology may allow asynchronous generators in hydro plants to operate effectively at almost any speed. The Rottenburg power station began generating electricity in March 1991; test runs on the pilot plant are under way. (Rochester-PTT) PTT W91-11213

EXPERIENCE WITH LOW-HEAD HYDRO-PLANT FREQUENCY CONTROL. Sulzer Bros. Ltd., Winterthur (Switzerland).

A. H. Glattfelder, J. Bucher, F. Studer, and L.

International Water Power and Dam Construction IWPCDM, Vol. 43, No. 5, p 20-23, May 1991. 6 fig, 3 ref.

Descriptors: \*Control systems, \*Electrical equipment, \*Frequency control, \*Hydraulic machinery, \*Hydroelectric plants, \*Low-head hydroelectric plants, Mathematical models, Performance evalua-

Generally, low-head hydroelectric units operate in a base load mode, which means that they deliver a base load mode, which means that they deliver power according to actual water flow and do not participate in frequency regulation. The speed governor only acts in the speed/no load condition to synchronize the output to the grid. A speed control system covering the whole load range of an isolated hydro plant has been developed, based on a proportional-integral governor and an electronic feedback module. A mathematical model was used to predeternine settings shortening the time of to predetermine settings, shortening the time of commissioning the system. Plant experiments were conducted and confirmed that, with an additional conducted and confirmed that, with an additional feedback module, the speed/frequency control loop was stable and damped sufficiently well over the whole load range in isolated operation. At partial loads below 50%, the speed control performance was acceptable, even for large load disturbance. Beak feedured designed in the control of turbances. Peak frequency deviations increased markedly, and control was much slower near to full load because of the necessary compensation for the increasing water hammer effect. (Rochester-PTT W91-11214

DEVELOPMENT OF SMALL HYDRO FOR REMOTE AREAS OF NORTHERN PAKISTAN. Northern Areas Public Works Dept., Gilgit (Pakistan).

R. A. Riaz, and N. Ali.

International Water Power and Dam Construction IWPCDM, Vol. 43, No. 5, p 24-26, May 1991. 1

#### Field 8—ENGINEERING WORKS

#### **Group 8C—Hydraulic Machinery**

Descriptors: \*Hydroelectric plants, \*Hydroelectric power, \*Pakistan, \*Turbines, \*Water resources development, Crossflow turbines, Developing countries, Economic aspects, Francis turbines, Human population, Hydraulic machinery, Management planning, Performance evaluation, Social aspects.

The Northern Areas of Pakistan, a remote region characterized by difficult terrain, could not be economically connected to the country's national economically connected to the country's national grid. Small hydro schemes therefore have a particularly important role to play in providing much needed supplies of electricity for the local population and stimulating the overall development of the area, particularly with regard to light industries and tourism. At present 48 stations operate to provide electricity for a third of the population. Work on another 30 stations is in progress and more are being planned. The development of small hydro schemes has changed the socioeconomic hydro schemes has changed the socioeconomic pattern of these areas and positive effects on the environment and ecology can be expected soon. Of the two types of turbines already in use (crossflow and Francis), experience has shown that the crossflow runners wear out relatively quickly. Frequent breakdowns are caused by poor metallurgy in the manufacture of guide vanes and runners. This ex-perience has led to a tendency to prefer Francis runners. Recently, growing populations and an increasing demand for electricity have forced planners to choose high-capacity (625 kVA to 123 kVA) Francis or Pelton turbines. (Rochester-PTT) W91-11215

DAMS AND SUSTAINABLE DEVELOPMENT IN BRAZILIAN AMAZONIA.

Monosowski Associate Consultants, Sao Paulo (Brazil).

E. Monosowski.

International Water Power and Dam Construction IWPCDM, Vol. 43, No. 5, p 53-54, May 1991.

Descriptors: \*Amazon River Basin, \*Brazil, \*Environmental effects, \*Environmental impact, \*Hydroelectric plants, \*Hydroelectric power, Dams, Economic aspects, Regional analysis, Regional planning, Social aspects, Water resources management

Hydropower dams are responsible for the production of about 95% of the electricity consumed in tion of about 95% of the electricity consumed in Brazil and they will remain its major source for at least the next 30 yr. Experience gained in recent years in Brazil's Amazonian region has encouraged the adoption of policy for the regional insertion of dams by a national power authority. Lessons learned in the past are therefore contributing to a review of environmental management practice. Be-cause of the topography of the Amazonian region, cause of the topography of the Amazonian region, the filling of reservoirs transforms large rivers into artificial lakes of vast dimensions (e.g., Tucurui reservoir, 2460 sq km, Balbian reservoir 4000 sq km, and planned Babaquara reservoir possibly 7000 sq km). Regional impacts on hydrology, changes in regional economic activity, pollution resulting from new industries, and deforestation were mainly unexpected consequences of existing dams. In the long-term, these impacts may reduce the regional development alternatives and even isonregional development alternatives and even jeop-ardize economic production of electricity in the region. To avoid these unintended consequences in the future, a broadened approach to planning and decision making is recommended. Interests, other than commercial interests, should be considered. The hydro projects should be constructed within the context of a regional growth plan and a sustainable development strategy for Amazonia as a whole. (Rochester-PTT) W91-11216

HYDROELECTRIC TURBINE SEITING: A RATIONAL APPROACH.

Canadian Journal of Civil Engineering CJCEB8, Vol. 18, No. 1, p 27-35, February 1991. 2 fig, 6 tab, 15 ref.

Descriptors: \*Hydraulic machinery, \*Turbines, Design criteria, Hydraulic engineering, Hydroelectric power, Mathematical equations.

There are no standards for the setting of a hydraulic turbine with respect to the tailwater level. Manufacturers rely on hydraulic model data to determine the required protection against cavitation, and they never publish these data. Utilities and consultants must rely on the interpretation of published statistical data relating submergence to vari-ous turbine parameters. An alternative approach has been devised wherein a general equation is developed relating the submergence of a stainless steel or cast steel runner to the number of runner blades, the plant capacity factor, the turbine throat velocity, the tailwater level above sea level, the velocity, the tailwater level above sea level, the water temperature, and the acceptable amount of cavitation. The equations have been tested on 39 different power plants having either horizontal or vertical axis Kaplan, propeller, or Francis turbines, both large and small. The equations are particularly useful for establishing the turbine diameter and setting during feasibility assessment and for comparing the manufacturer's suggested turbine parameters in the final design stage. The countries rameters in the final design stage. The equations also can be used to determine the capacity of a new runner in an existing casing. (Author's abstract) W91-11274

FLOW THROUGH GATED CONDUITS AT PARTIAL AND FULL GATE OPENINGS.

Agriculture Canada, Regina (Saskatchewan). Research Station.

R. L. Powley, and B. H. Haid.

Canadian Journal of Civil Engineering CJCEB8, Vol. 18, No. 1, p 43-52, February 1991. 14 fig, 18

Descriptors: \*Hydraulic models, \*Reservoirs, \*Slide gates, Comparison studies, Hydraulic engineering, Irrigation engineering, Performance eval-

Prairie Farm Rehabilitation Administration (PFRA), a branch of Agriculture Canada, has responsibility for care and custody of approximately 120 dams built for irrigation, stock watering, and other uses. Most of these dams are between 5 and 20 m in height and include riparian or irrigation outlet structures controlled by vertical slide gates. Criteria were developed to evaluate the discharge configuration at the gate. Relationships were determined between discharge, upstream energy level, mined between discharge, upstream energy level, gate opening, and downstream submergence. A test program based on hydraulic modeling was conducted. Two gate shapes were tested: a circular gate similar to the Armco Model 20-10C and a square gate similar to the Armco 55-10. It was shown that a unique contraction coefficient exists for a given gate at a given gate opening, but that discharge for a given unstream energy level dedischarge for a given upstream energy level de-pends on whether the gate discharges freely or is submerged downstream. Situations involving par-tial submergence generally do not need to be accounted for in practice; such situations generally occur only at relatively large gate openings. The study showed that, for the method of analysis used, the contraction coefficients are quite similar for two very dissimilar gates controlling a circular section. While this tends to imply that contraction coefficients for gated sections are fairly insensitive to gate shape, the results of tests on a greater variety of gates would be required to prove this. (Rochester-PTT) W91-11276

HYDRAULICS OF CULVERT FISHWAYS IV: SPOILER BAFFLE CULVERT FISHWAYS. Alberta Univ., Edmonton. Dept. of Civil Engineering. For primary bibliographic entry see Field 8I. W91-11279

INTAKE DEVICES FOR DREDGES WITH SUB-MERSIBLE SUCTION PUMPS.

S. P. Ogorodnikov, I. I. Mikheev, A. E. Kulakov, and N. N. Kozhevnikov.

No. 6, p 372-374, December 1991. 2 fig, 3 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, pp. 15-16, June, 1990.

Descriptors: \*Dredging, \*Hydraulic machinery, \*Intakes, Design criteria, Hydraulic engineering, Hydraulic rippers, Nozzles, Optimization, Performance evaluation, Pumps, Soviet Union.

In the Soviet Union and elsewhere, experimental models of dredges with submersible centrifugal suction pumps have been created and tested. High efficiency has been demonstrated: with a given intake of the mud-and-water mixture and hydraulic transport, the output can increase by 1.5 times. A transport, the output can increase by 1.5 times. A study was conducted aimed at optimizing the intake portion of the transport process as it relates to these submersible pumps used in dredging. First, it was shown that submersible pumps are effective not only at large dredging depths (i.e., within the limit values of the vacuum in the suction line), but at the usual depths (less than 10-12 m), when cavitation effects in the suction pump are small. The Kalinin Polytechnic Institute designed an improved intake device for the 330-501 number 463 ne Raimin Poytecnic institute designed an improved intake device for the 350-50 L number 463 dredge with a submersible centrifugal suction pump of type 20R-11. The improved intake device consisted of a modernized suction nozzle and a hydraulic ripper. During tests, the hydraulic trans-port system of this dredge consisted of two 20Rport system of this dredge consisted of two 20R-11M pumps (bilge and submersible) connected in series. The water discharge of each pump was 3600 cu m/hr; the head of the submersible pump was 30 m, whereas it was 60 m for the bilge pump. The optimization of parameters of the intake device on the 350-50L dredge with the submersible pump led to an output increase on sand soils of 51% with the ripper and 26% without the ripper. Later tests with a modified device confirmed these results. (Rochester-PTT) W91-11287

OPERATING EXPERIENCE AND SUGGESTIONS ON RECONSTRUCTION OF THE TURBINES OF THE DNEPR-I HYDROELECTRIC

I. P. Ivanchenko, and V. I. Platov

Hydrotechnical Construction HYCOAR, Vol. 24. No. 6, p 389-397, December 1991. 4 fig. 2 tab, 5 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, pp. 26-31, June, 1990.

Descriptors: \*Dnepr River, \*Hydraulic engineering, \*Hydroelectric plants, \*Soviet Union, \*Turbines, Design criteria, Efficiency, Numerical analysis, Performance evaluation, Rehabilitation, Reli-

A review of the 40-yr operating experience at the Dnepr (Soviet Union) hydroelectric station as it relates to reliability and operating efficiency at the Dnepr-I part of the hydroelectric station has demonstrated a need to rebuild the turbines. The residual of the property of the prope onstrated a need to rebuild the turbines. The reasons are as follows: (1) the present operating conditions differ markedly in head from those in the original design, with the result that turbine efficiency in the main load regimes is 5-8% lower than the optimal; (2) because of numerous welds of the blades during repair of cavitation erosion, deformation of the blade system has occurred, resulting in a loss of turbine efficiency of 1.5%; (3) the existing runners are of obsolete design; and (4) reliability indices of the equipment are decreasing steadily. Computer calculations were conducted with the aim of selecting the optimal parameters (turbine power and speed) of a new turbine at the time the reconstruction of the hydroelectric station takes place. These calculations were done in contime the reconstruction of the hydroelectric station takes place. These calculations were done in conformity with the actual operating conditions. On the basis of the criterion of the maximum weighted average efficiency, the new turbine should have the following characteristics: rotation speed 88.2/min, rated power 74.0 MW at head = 35.5 m, and average efficiency 94.8%. On the basis of the criterion of obtaining a maximum power on the new turbine, the following values would be desirable: rotation speed 90.9/min, rated power 78.0 MW at head = 35.3 m, and average efficiency = 94.5%. To increase the efficiency and operating reliability of the existing equipment (before reconstruction), it is recommended that the power of the turbines be limited by opening the gate apparatus. (Rochester-PTT) ter-PTT) W91-11290

#### Soil Mechanics-Group 8D

STABILITY OF HYDROPOWER CONSTRUCTION PROGRAMS,

B. L. Erlikhman. Hydrotechnical Construction HYCOAR, Vol. 24, No. 6, p 418-422, December 1991. 5 ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No. 6, pp.

Descriptors: \*Electric power production, \*Hydro-electric power, \*Soviet Union, Caucasus, Central Asia, Dam construction, Economic aspects, Man-agement planning, Siberia.

The gross hydropower potential of the Soviet Union can be taken with some certainty to be 4 trillion kWh/yr, but the calculated technically feasible potential of 2.1 trillion kWh/yr may be an underestimate. More than 25 yr ago, the total economic potential was calculated as 1095 billion kWh/yr. Increased demands for water in multipurpose reservoirs, the age of some of the plans for hydropower stations, and the changing role of hydropower in the overall electrical supply industry make the problem of calculating future hydropower growth more complex than in the past. Considerable replanning of hydrostations and schemes lies ahead. Without this effort, the value of the economic potential of hydropower resources The gross hydropower potential of the Soviet schemes has an earl. Without his error, the value of the economic potential of hydropower resources cannot be refined and the drawing up of the program of development of hydropower cannot be completed. Preliminary calculations show that the previously calculated economic potential of hydropower resources of the Caucasus and parts of the Siberian and Central Asian regions will remain the same or increase, whereas in central, southern, and northwestern regions of the European USSR, western Siberia, and certain parts of the Far East the potential will decrease. (Rochester-PTT) W91-11294

ST. JOHNS BAYOU PUMPING STATION, MISSOURI: HYDRAULIC MODEL INVESTI-

Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab. B. P. Fletcher.

B. P. Fletcher.
Available from the National Technical Information
Service, Springfield, VA. 22161, as AD-A234 193.
Price codes: A03 in paper copy, A01 in microfiche.
Technical Report HL-911-3, January 1991. Final
Report. 46p, 7 fig, 1 tab, 1 photo, 22 plates.

Descriptors: \*Hydraulic machinery, \*Hydraulic models, \*Pumping plants, \*Pumping stations, \*St Johns Bayou, Channel flow, Costs, Flow pattern, Missouri, Model studies, Pumps.

The design of the proposed St. Johns Pumping Station at New Madrid, MO, consisted of three vertical pumps with a total capacity of 1,000 cu ft/s. A 1:11.5-scale pumping station model of the pump intakes, sump, and inlet channel was used to investigate and develop a practical design that would provide satisfactory hydraulic performance. The model tests revealed that prototype construc-tion costs could be reduced by reducing the sump length and the angle of the approach wing walls. Initially, adverse flow distribution and excessive antiany, adverse now distribution and excessive swirl were measured in the pump intakes. A pump intake design was developed that had insignificant swirl and provided good flow distribution for an-ticipated flow conditions. (Author's abstract) W91-11588

#### 8D. Soil Mechanics

CHANGE IN PORE SIZE DISTRIBUTION OWING TO SECONDARY CONSOLIDATION

New Brunswick Dept. of Transportation, Fredericton. Materials and Research Branch.
F. J. Griffiths, and R. C. Joshi.

adian Geotechnical Journal CGJOAH, Vol. 28, No. 1, p 20-24, February 1991. 4 fig, 2 tab, 24

Descriptors: \*Clays, \*Compressibility, \*Pore size, \*Soil mechanics, \*Soil structure, Consolidation, Deformation, Permeability, Pore pressure, Soil analysis, Soil porosity, Soil properties.

Secondary consolidation has long been utilized as a Secondary consolutation has long ocen unitized as a useful concept for settlement analysis. The rate-setting mechanism is viewed as the permeability of the soil during the primary phase, whereas second-ary compression is considered as the deformation that occurs at a constant effective stress. The exact nature of and reason for secondary compression in clay soils has been evaluated in a series of laboratociay soils has been evaluated in a series of laboratory experiments conducted using mercury-intrusion porosimetry (MIP). The amount of secondary consolidation was varied for several samples of three soil types by holding the consolidation stress steady at 120 kPa for different durations. The steady at 120 kPa for different durations. The results of the investigation revealed that secondary deformation could be seen as a reduction in pore volume generally in the 100-1000 nm range. Examination of the pore size distribution curves revealed that secondary consolidation could not be due solely to the deformation of micropores. Rather, reduction was due to a loss of entrapped pore space as well as a component of volume change in the free pores. The relative degree of change in total, free and entrapped porosity appeared to be related to the proportion of each initially in the sample. The greater the proportion of free pore space, the greater the amount of the reduction in free pore space owing to secondary compression. (Korn-PTT)

ANALYSIS OF THREE-DIMENSIONAL GROUND MOVEMENTS: THE THUNDER

GROUND MOVEMENTS: THE THUNDER BAY TUNNEL.
University of Western Ontario, London. Geotechnical Research Centre.
For primary bibliographic entry see Field 8A.
W91-10775

FINITE-ELEMENT ANALYSIS OF SOFTEN-ING EFFECTS IN FISSURED, OVERCONSOLI-DATED CLAYS AND MUDSTONES. Alberta Univ., Edmonton. Dept. of Civil Engi-

N. Yoshida, N. R. Morgenstern, and D. H. Chan. Canadian Geotechnical Journal CGJOAH, Vol. 28, No. 1, p 51-61, February 1991. 17 fig, 1 tab, 36

Descriptors: \*Clays, \*Finite element method, \*Model studies, \*Soil mechanics, \*Soil properties, \*Soil strength, Deformation, Excavation, Plasticity, Pore pressure, Slopes, Soil absorption capacity, Soil stabilization, Strength, Stress, Yield equations.

Fissured, overconsolidated clavs and mudstones rissured, overconsolidated clays and mudstones soften with time due to water absorption upon unloading. The effect of softening is a decrease in shear strength accompanied by a diminishing tendency to dilate. The reduction of shear strength due to softening can be represented as a lowering of the failure envelope and a reduction in the high nonlinearity at low stress levels. The softening nonlinearity at low sites levels. The softening process may be formulated in terms of a time-dependent yield surface, and the finite-element method can be extended to analyze softening effects. A finite element analysis was carried out for fects. A finite element analysis was carried out for a cut slope and revealed variations in vertical and horizontal displacements with time. Time-dependent development of deformations and plastic zones were computed as yielding progressed. The displacements developed when the excavation was completed but before the pore-water pressures were replaced with steady-state values taken as zero. This allowed an evaluation of the influence of the pore-water pressure change on the slope behavior. The pore-water pressure replacement rebehavior. The pore-water pressure replacement resulted in large upward displacements at both the crest and the toe. Horizontal displacement initially increased gradually at both the crest and the toe for a period of 50 years after excavation. However, for a period of years after excavation. However, horizontal displacement increased rapidly as the slope approached collapse, in association with the progression of yielding. Vertical displacement at the toe followed the same trend as the horizontal the total own the same trend as the horizontal displacement, but at the crest only a small downward displacement developed. The lifetime of the slope was calculated as 95 years. (Korn-PTT) W91-10776

ELECTROOSMOTIC STRENGTHENING OF SOFT SENSITIVE CLAYS.

University of Western Ontario, London, Dept. of Civil Engineering. K. Y. Lo, I. I. Inculet, and K. S. Ho.

Canadian Geotechnical Journal CGJOAH, Vol. 28, No. 1, p 62-73, February 1991. 14 fig, 4 tab, 25 ref. National Sciences and Engineering Research Council of Canada Grant No. OPG0007745.

Descriptors: \*Clays, \*Electro-osmosis, \*Pore pres-sure, \*Soil mechanics, \*Stress analysis, Analytical techniques, Consolidation, Electrodes, Experimen-tal design, Measuring instruments, Soil moisture retention, Soil properties, Soil strength, Stress-

A comprehensive experimental investigation on the electroosmotic strengthening of soft sensitive clay was performed to assess the effectiveness of the treatment and to study the mechanism of the process. A specially designed electroosmotic cell was developed to prevent gas accumulation near the electrodes, to allow better electrode-soil contact, and to improve the treatment efficiency. This apparatus also enables the monitoring of the generated negative pore-water pressure along the sample length, settlement, voltage distribution, and current variation during treatment. The investigation covered two different types of soil trimmed at different orientations: the vertically and horizontally ent orientations: the vertically and horizontally trimmed overconsolidated Wallaceburg clay and the vertically trimmed slightly overconsolidated soft sensitive Gloucester (Leda) clay. Results of soft sensitive Gloucester (Leda) clay. Results of this study showed that the voltage distribution and induced negative pore pressure at equilibrium along the sample are linear with steady current flow across the sample, indicating that the elec-trode design in the electroosmosis test apparatus is efficient. The electroosmotic consolidation curve is similar to that of the conventional consolidation curve and the preconsolidation pressure was insimilar to that of the conventional consolidation curve, and the preconsolidation pressure was increased by 51-88% with an applied voltage up to 6V. The undrained shear strength increased to a maximum of 172%, and the moisture content decreased by 30%. The technique of electrode reversal was employed, and a relatively uniform strength increase between the electrodes was obed. (Author's abstract) W91-10777

FIELD TEST OF ELECTROOSMOTIC STRENGTHENING OF SOFT SENSITIVE

University of Western Ontario, London. Dept. of Civil Engineering.
K. Y. Lo, K. S. Ho, and I. I. Inculet.

K. Y. Lo, K. S. Ho, and I. I. Incutet. Canadian Geotechnical Journal CGJOAH, Vol. 28, No. 1, p 74-83, February 1991. 14 fig. 1 tab, 13 ref. National Sciences and Engineering Research Council of Canada Grant Nos. OPG0007745 and

Descriptors: \*Clays, \*Electro-osmosis, \*Field tests, \*Soil mechanics, \*Soil strength, Cathodes, Electrodes, Instrumentation, Interstitial water, Monitoring. Polarity. Soil properties.

A field test was undertaken to assess the effectiveness of electroosmosis in strengthening the soft sensitive (Leda) clay at the Gloucester test fill site. Specially designed copper electrodes were in-Specially designed copper electrodes were installed to prevent gas accumulation around the electrode and to allow pore water in the soil to flow out from the cathode without pumping. The variation of settlement, shear strength, and voltage distribution during treatment was measured, and tube samples were recovered before and after treatment for laboratory tests. The results of field vane tests at different locations within the treated area and at different innes indicate that the undrained shear strength increased uniformly by approximately 30% for a period of 32 days throughout the depth of the electrodes. Concurrently, an average surface settlement of 50 mm was achieved. The total project cost, indicating that the design of the treatment system was efficient. It is evident, therefore, that substantial increase in strength as the treatment system was efficient. It is evident, therefore, that substantial increase in strength as well as general improvement in soil properties may be achieved by this improved version of electroosmosis. The elimination of pumping improved the economy of the process considerably. It is hoped

#### Field 8—ENGINEERING WORKS

#### Group 8D-Soil Mechanics

that the process may receive wider application as a result of these improvements. (Author's abstract) W91-10778

MECHANISTIC EVALUATION OF MITIGA-TION OF PETROLEUM HYDROCARBON CONTAMINATION BY SOIL MEDIUM. McGill Univ., Montreal (Quebec). Geotechnical Research Centre.

For primary bibliographic entry see Field 5G. W91-10779

ANALYSIS OF A SANITARY-EMBANKMENT FAILURE OVER THE RIO DE JANEIRO SOFT CLAY DEPOSIT.

CLAY IDEPOSIT.
Rio de Janeiro Bureau of Public Works (Brazil).
R. P. da Cunha, and W. A. Lacerda.
Canadian Geotechnical Journal CGJOAH, Vol.
28, No. 1, p 92-102, February 1991. 17 fig, 18 ref.

Descriptors: \*Clays, \*Embankments, \*Foundation failure, \*Hydraulic structures, \*Landfills, \*Soil mechanics, Case studies, Cohesion, Load distribution, Pore pressure, Rio de Janeiro, Sanitary landfills, Soil properties, Soil stabilization, Soil tests, Stability analysis, Strength, Stress.

An investigation was undertaken to analyze an embankment failure over a soft clay deposit in the district of Caju, Rio de Janeiro. The area has sanitary and rubble embankments. The main difficulty of the analysis lies in the indiscriminate filling in the region, which has led to a series of foundation failures, including under and around the embankment. Index tests were performed to obtain geotechnical characteristics and a profile of the soft clay deposit. Odometer tests, in situ and laboratory vane tests, standard penetration tests, and conventional triaxial tests were also carried out. Total stress calculations were used to interpret and back analyze the failure and also to obtain the mobilized shear strength at both the fill and clay foundations. It was concluded that the failure was caused by the land increase of a recent embankment composed predominantly of rubble material. This caused a pore pressure increase in the unconsolidated soft clay. It is believed that the effective pressures inside the clay had a magnitude similar to the maximum past pressure of the respective strata. The vane test results showed erratic variability of the undrained shear strength of this deposit. There was a mobilization of a certain amount of shear strength in the embankment body. With the assumption of a 35-degree friction angle for the embankment, the calculated cohesion had a magnitude of between 0-20 kPa. (Korn-PTT)

COMPARISON OF FIELD CONSOLIDATION WITH LABORATORY AND IN SITU TESTS. British Columbia Univ., Vancouver. Dept. of Civil

Engineering.
C. B. Crawford, and R. G. Campanella.
Canadian Geotechnical Journal CGJOAH, Vol. 28, No. 1, p 103-112, February 1991. 14 fig, 3 tab, 18 ref.

Descriptors: \*Embankments, \*Soil engineering, \*Soil mechanics, \*Soil properties, \*Soil stabilization, Compressibility, Consolidation, Field tests, In situ tests, Piezometers, Pore pressure, Soil analysis, Strength, Stress, Structural engineering.

The use of in situ tests to predict consolidation settlements is of considerable interest to foundation negineering practices. In recent years, theories and correlations have been developed in an effort to relate in situ test results to the magnitude and rate of soil consolidation as stress increases, but full-scale observations are required to assess their reliability. A series of settlement calculations was conducted for an earth embankment resting on the soft, compressible sediments of the Fraser River Delta in British Columbia. The calculations were made from laboratory consolidation tests and from in situ tests using a piezocone and a flat dilatometre. The calculated values were then compared with measured settlements. There was rather good agreement among the three methods of calculation, but the actual settlement was about 60% greater

than the average calculated value. The reasons for this discrepancy are not known. It is likely that a significant part of the measured settlement may have been due to lateral spreading under the shoulders of the fill in the very sensitive subsoil. Another possibility is that the construction of the sand drains caused disturbance of the subsoil and that this resulted in increased consolidation settlement. Although there is good agreement among the prediction methods, the comparison with observed settlement is not satisfactory. Further field research is needed to determine how movement occurs, both vertically and laterally, and laboratory studies on better soil samples are required to improve understanding of the material properties. (Korn-PTT)

PRESSURE OF CLAY BACKFILL AGAINST RETAINING STRUCTURES.

Surrey Univ., Guildford (England). Dept. of Civil Engineering. C. R. I. Clayton, I. F. Symons, and J. C. Hiedra-Cobo.

Canadian Geotechnical Journal CGJOAH, Vol. 28, No. 2, p 282-297, April 1991. 18 fig, 1 tab, 31 ref.

Descriptors: \*Backfill, \*Check structures, \*Retaining walls, \*Soil pressure, \*Structural engineering, Clay soils, Cohesive soils, Plasticity, Soil compaction, Soil water. Stress.

Most earth retaining structures require placement of backfill material adjacent to the wall. A study was made of the pressures exerted by clay backfills against retaining structures. The lateral pressures were developed during three main phases: placement, compaction, and burial; horizontal total stress reduction at constant moisture content; and swelling or consolidation under approximately constant vertical stress. Experimental data from laboratory and pilot-scale studies, using clays of intermediate and high plasticity, were used to assess the magnitude of the pressure changes in each phase. Laboratory experiments showed that the maximum horizontal total stress that can remain after compaction is a function of the undrained shear strength of the clay and of its plasticity. Results of pilot-scale experiments indicate horizontal total stresses at the end of construction of about 0.2 and 0.4 for the intermediate and high-plasticity clays, respectively. It was concluded that previously-developed theories for assessing the pressures on retaining walls developed by compaction of granular soils are inapplicable for cohesive soils. Compaction pressures do not become significant until the air void content of the fill is reduced to less than 15%. The results from a preliminary numerical study were used to provide an indication of the likely effects of plasticity and placement moisture content. For well-compacted low-plasticity clays (Pl < 30%) swelling of the fill is less likely indices up to about 40%, swelling problems can probably be avoided if the placement moisture content is greater than a critical value. For clays of higher plasticity the fill is likely to be barely trafficable at this critical moisture content and some swelling will need to be allowed for, at least near the top of a rigid retaining structure. (Fish-PTT)

DEEP-SEATED CONSOLIDATION SETTLE-MENTS IN THE FRASER RIVER DELTA. British Columbia Univ., Vancouver. Dept. of Civil

Engineering.
C. B. Crawford, N. R. McCammon, and R. C. Butler.

Butler.
Canadian Geotechnical Journal CGJOAH, Vol. 28, No. 2, p 298-303, April 1991. 7 fig, 3 ref.

Descriptors: \*Canada, \*Deltas, \*Foundation failure, \*Soil compaction, \*Structural engineering, \*Structural settlement, Alluvial plains, British Columbia, Sediment sampling.

During the past 35 years, two cement plants have been built along the south channel of the Fraser River delta near Vancouver, British Columbia, Canada, in an area where a compressible layer of marine sediments occurs to a considerable depth below a thick layer of alluvial sand. Three heavy silo structures at the two plants have experienced settlement since the plants' construction in 1956. In this area, it has not been possible to obtain sufficiently undisturbed samples for reliable consolidation tests, and it has been necessary therefore to employ in situ tests and site improvement techniques such as preloading and vibrocompaction for the design of subsequent foundations in the same region. In some cases, piles were used to redistribute heavy loads. Observations during the past 35 years have shown that most of the consolidation settlement has occurred in a deep layer of marine sediments and that it was largely completed within 10 years of the loading. (Author's abstract)

# 8E. Rock Mechanics and Geology

GEOTECHNICAL APPRAISAL OF THE FOUN-DATION ROCK MASS BEHAVIOUR OF NAR-MADA SAGAR DAM PROJECT, CENTRAL INDIA: A CASE STUDY.

INDIA: A CASE STOPY.
Indian School of Mines, Dhanbad.
V. D. Choubey, and S. Chaudhari.
Canadian Geotechnical Journal CGJOAH, Vol.
28, No. 1, p 148-159, February 1991. 12 fig, 4 tab,
20 ref.

Descriptors: \*Dam foundations, \*Dam stability, \*Dams, \*Hydraulic structures, \*India, \*Rock mechanics, Dam construction, Deformation, Elastic properties, Permeability, Rock properties, Shear, Strength.

The Narmada Sagar Dam, a concrete gravity structure under construction across the Narmada River in central India, will have a crest length of 653 m and a maximum height of 92 m. Geotechnical investigations were undertaken to evaluate the quality of the rock mass foundations and to recommend further core drilling to characterize the rock mass foundation. The foundation rock mass consists of quartzite intercalated with thin bands of siltstone, grits, and conglomerates. The analysis of the in situ permeability tests suggests that the relatively high permeability of the foundation rock mass is due to an interconnected network of water-conducting joints. It is suggested that the estimate of spacing and opening of the water-conducting joints may lead to useful estimates of the groutable volume of voids in the rock mass, and inclined drill holes are preferable for optimum grouting. A systematic study of six divided geostructural zones suggests that the foundation rocks are fair for the construction of a concrete gravity structure on hem. Shear zones are classified as very poor rock, as they consist of gougy, sheeted, and brecciated material. These zones will be more pervious to water flowing along it rather than being perpendicular to the channel. The properties of the green siltstone layers are very important for design purposes because it is clear that the strength of the foundation of green siltstone, which is the weakest material within the foundation rocks are competent and suitable for designing the proposed concrete gravity dam. (Korn-PTT)

# SEISMIC HAZARD AT NARMADA SAGAR DAM.

National Geophysical Research Inst., Hyderabad (India). N. K. Brahmam.

Current Science CUSCAM, Vol. 59, No. 23, p 1209-1211, 1990. 3 fig, 18 ref.

Descriptors: \*Dam construction, \*Dam safety, \*Earthquake engineering, \*Geologic fractures, \*India, \*Seismic waves, Dam design, Earthquakes, Gravity waves.

The Narmada Rift in India has been regarded as a major crustal feature of ancient origin. This region

# Materials—Group 8G

has now assumed significance because many major and minor projects for irrigation and power are planned across the Narmada river and its tributaries. The course of the river is tectonically controlled in the sense that the river is flowing along the southern fault of the rift. A major part of the gravity 'low' north of the river, as seen by gravity gravity 'low' north of the river, as seen by gravity anomaly maps, is caused by downfaulting of the high-velocity layer from a depth of 8 to 13 km. At least one earthquake of magnitude 6.3 has been historically recorded in the Narmada river region, and reliable gravity maps are now freely available, so the concerned engineers should take into account all possible safety measures when constructing the newest Sagar Dam. Since precise prediction of earthquakes is not possible, new structures in this area should be designed that can withstand earthquakes of magnitude 6.5 or 7.0. (Fish-PTT) W91-10949

#### 8F. Concrete

PREDICTING CONCRETE SERVICE LIFE IN CASES OF DETERIORATION DUE TO FREEZ-ING AND THAWING.
JAYCOR, Vicksburg, MS.
L. M. Bryant, and P. F. Mlakar.
Available from the National Technical Information Service, Springfield, VA. 22161. Army Corps of Engineers Technical Report REMR-CS-35, March 1991. Final Report. 108p, 40 fig, 2 tab, 10 ref, 2 append. DOA Contract No. DACW39-87-C-0059.

Descriptors: \*Concrete, \*Deterioration, \*Freeze-thaw tests, Concrete construction, Concrete test-ing, Data interpretation, Decomposition, Model studies, Seepage, Temperature.

A procedure for predicting the service life of non-air-entrained concrete subject to damage due to freezing and thawing has been developed which addresses both the known and uncertain qualities of the relevant material properties, environmental factors, and model of degradation due to freezing and thawing using a probabilistic method. Two important characteristics of this procedure are: (1) it rationally addresses the uncertainties inherent in degradation of mass concrete due to freezing and thawing; and (2) the procedure is mathematically straightforward for implementation by Corps of Engineers offices. From six candidate structures, two features were selected as case studies for applitwo features were selected as case studies for appli-cation of the procedure. These two features were the middle wall and the land wall at Dashields Lock. The procedure was applied using the avail-able data for each case study. One-dimensional and two-dimensional thermal analyses were used to determine the thermal response of each wall and the resulting probabilities of critical temperature. Simplified seepage analyses provided the probabil-ties of critical saturation. The annual probability plified seepage analyses provided the probabil-of critical saturation. The annual probability of damage and the predicted service life were determined from the joint probabilities of critical determined from the joint probabilities of critical temperature and critical saturation throughout the structure. Several important conclusions can be reached from this study. Current procedures for thermal modeling and analysis appear quite adequate for predicting temperatures in a concrete structure. Although 2-D analyses are better for determining complex thermal response, in many cases a series of much simpler 1-D analyses provide a very good estimation of temperatures. The external temperature inputs to a thermal analysis, ie., water and air temperatures, were shown to be well represented by sinusoidal curves. An examination of the temperature distribution for any point in the structure indicated that the primary contributor to uncertainty of response was the annual variation of temperature. This important observation permits the probabilistic analysis to use the results of only a single thermal analysis at the mean values of the input factors. The procedure, therefore, provides excellent agreement with observed damage due to freezing and thawing at the two sites studied. (Lantz-PTT)

NONLINEAR EARTHQUAKE RESPONSE OF CONCRETE GRAVITY DAM SYSTEMS. California Inst. of Tech., Pasade

B. El-Aldi.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-193924. Price codes: Al 0 in paper copy, AO in microfiche. Report No. EERL 88-02, 1989. 191p, 76 fig., 2 tab, 51 ref, 5 append. NSF Grant Nos. CEE81-19962, CEE83-17257, and CES-8619908.

Descriptors: \*Concrete dams, \*Dam failure, \*Dam stability, \*Earthquakes, \*Gravity dams, Cavitation, Cracks, Hydraulic structures, Hydrodynamics, Mathematical studies, Model studies, Reservoirs,

The earthquake response of concrete gravity dam systems is investigated with emphasis on the non-linear behavior associated with tensile concrete cracking and water cavitation. A single dammonolith is considered and assumed to respond independently as a two-dimensional system under monoitti is considered and assumed to respond independently as a two-dimensional system under plane stress conditions; the two-dimensional assumption is also extended to model the compressible water body impounded upstream of the dam. Standard displacement-based finite element techniques were used to spatially discretize the field equations and produce a single symmetric matrix equation for the dam-water system. Energy dissiequation for the dam-water system. Energy dissi-pation in the reservoir, through radiation in the infinite upstream direction and absorption at the bottom, is approximately accounted for, and a set of numerical examples is presented, to demonstrate the accuracy of the present formulation in model-ing the linear earthquake response of infinite reser-voirs. Water cavitation is modeled by a smeared approach which uses a bilinear pressure-strain rela-tion. It is shown that the water response becomes tion. It is shown that the water response becomes dominated by spurious high frequency oscillations upon closure of cavitated regions, and improved results can be obtained by using some stiffness-proportional damping in the water reservoir. As demonstrated in an example analysis of Pine Flat Dam (linear dam), cavitation occurs in the upper part of the reservoir along the dam face, unlike other investigations which show cavitated regions at considerable distances from the dam; both the tensile pressure cutoffs and compressive impacts have a minor effect on the dam response. Propagation of cracks is monitored in an interactive envinave a minor elect on the cam response. Propaga-tion of cracks is monitored in an interactive envi-ronment which uses an equivalent strength crite-rion and allows for user input; remeshing is avoid-ed. The algorithm adopted here produces narrow cracks (unlike many other investigations which show large zones of cracking) illustrating that cracking reduces the hydrodynamic pressures in the reservoir and, hence, reduces water cavitation.

SEISMIC FRACTURE ANALYSIS OF CON-CRETE GRAVITY DAMS.
Concordia Univ., Loyola Campus, Montreal (Quebec), Dept. of Civil Engineering.
O. A. Pekau, Z. Chuhan, and F. Lingmin. Earthquake Engineering and Structural Dynamics IJEBG, Vol. 20, No. 4, p 335-354, April 1991. 11 fig. 3 tab, 14 ref, append. Natural Sciences and Engineering Research Council of Canada Grant No. A8258.

Descriptors: \*Concrete dams, \*Dam stability, \*Gravity dams, \*Hydraulic structures, \*Seismic properties, Boundary conditions, Cracks, Dam failure, Earthquake engineering, Earthquakes, Finite element method, Load distribution, Load testing, Mathematical studies, Numerical analysis, Seismic exploration, Stress analysis exploration, Stress analysis.

Since the Hsinfengkiang dam in China and the Koyna dam in India experienced very similar severe cracking damage during strong earthquakes in 1962 and 1967, considerable attention has focused on evaluating the safety of existing dams and predicting the dynamic performance of newly designed concrete dams subjected to strong earthquakes. A numerical procedure has been developed for the evaluation of the fracture process of gravity dams during strong earthquakes. The Boundary Element Method (BEM) is used to discretize the dam reservoir system including the crack surfaces, and stress intensity factors at the crack tip are employed in a stage by stage procedure which simulates the crack extension. For each

stage of constant crack length the mode superposition technique is applied. This is made possible by simulating the impact process of crack closing by a load pulse applied at the contact points which permits the assumption that the structural stiffness is unchanged. To verify the proposed procedure, a cantilever beam model structure made of gypsum was tested on a shaking table. Good correlation with the numerical results was obtained, from which it is concluded that the procedure can be employed for evaluation of the crack propagation process in concrete structures subjected to dynamic loadings. (Korn-PTT) ic loadings. (Korn-PTT) W91-10787

TESTING OF CELLULAR CONCRETE REVET-MENT BLOCKS RESISTANT TO GROWTHS OF REYNOUTRIA JAPONICA HOUTT (JAPA-

OF REINOUTRIA JAPONICA HOUTT (JAPANESE KNOTWEED),
University Coll., Cardiff (Wales). School of Pure and Applied Biology.
D. J. Beerling.

D. J. Beerling. Water Research WATRAG, Vol. 25, No. 4, p 495-498, April 1991. 4 fig, 1 tab, 6 ref.

Descriptors: \*Bank protection, \*Concrete construction, \*Introduced species, \*Japanese knotweed, \*Riprap, \*Weed control, Colonization, Flood control, Grasses, Porosity, Stream banks.

Flood control, Grasses, Porosity, Stream banks. On the banks of the River Cynon in Aberdare, South Wales, seven designs of flood revetment blocks were tested for resistance to penetration and displacement by Reynoutria japonica, an introduced alien now widespread on river banks in some areas. With the subsequent failure of all designs tested, the testing of a new block was undertaken. The problem with the current block types is caused by the large vertical macro-voids, which are filled with soil and whilst providing a suitable habitat for colonization by small herbaceous plants and grasses, also enable established plants to produce new shoots which may penetrate these voids. The new design performed better than the current designs because it had both a microporous structure and interlocking edges which prevented intra and interblock growths of R. japonica. However, despite the growth of grasses on the miniature blocks described, an aesthetically pleasing grass surface failed to appear on the new design in field trials, which was a result of a long dry summer in 1989 killing the grass seedlings 1 week after emergence. (Agostine-PTT)

#### 8G. Materials

PREDICTING CONCRETE SERVICE LIFE IN CASES OF DETERIORATION DUE TO FREEZ-ING AND THAWING.
JAYCOR, Vicksburg, MS.

For primary bibliographic entry see Field 8F. W91-10734

THERMAL-PULSE FLOWMETER FOR MEAS-URING SLOW WATER VELOCITIES IN BORE-HOLES

Geological Survey, Denver, CO. A. E. Hess.

A. E. ress.

Available from the US Geological Survey, Books and Open-File Reports Section, Box 25425, Federal Center, Denver, Co 80225-0425. Open-File Report 87-121, 1990. 70p, 49 fig, 4 tab, 17 ref.

Descriptors: \*Borehole geophysics, \*Boreholes, \*Flow velocity, \*Flowmeters, \*Instrumentation, \*Measuring instruments, \*Thermal-pulse flowmeters, Data acquisition, Handbooks, Hydraulic

The US Geological Survey has developed an all electronic, thermal-pulse flowmeter for measuring slow axial-velocities of water in boreholes. The flowmeter has no moving parts, but senses the movement of water (or any other fluid) by a thermal-tag/trace-time technique. In the configuration shown in this report, the flowmeter can measure water velocities ranging between about 0.1 to 20 ft/min, can resolve water velocity differences as

#### Field 8—ENGINEERING WORKS

#### **Group 8G—Materials**

small as 0.03 ft/min, and distinguish between upward and downward flow. Two diameters of interchangeable flow sensors are described--the smaller sensor is 1.75 inches in diameter including the collapsed centralizer, and the larger is 2.75 the collapsed centralizer, and the larger is 2.75 inches in diameter with collapsed centralizer. The flowmeter probe is 48 inches long and has been tested and used in tubes and boreholes with diameters ranging from 2 to 10 inches. The flowmeter also should be useful for measuring slow velocity flows in larger diameter boreholes, though for best accuracy it should be calibrated for flow at the diameter of the horehole in which it is to be used diameter of the borehole in which it is to be used. The flowmeter probe has been designed to withstand a water pressure depth of 10,000 feet. The report includes a description of the operation of the flowmeter, functional diagrams, mechanical drawings, and electronic schematics for both the flowmeter probe and surface electronics. Lists of parts and materials, and instructions for fabrica-tion, assembly, and calibration also are included. tion, assembly, and calibration also are included. These diagrams and lists should be adequate to permit the construction and use of a thermal-pulse flowmeter system by those skilled in machining and fabrication, electronics fabrication, and borehole metrology. (Author's abstract) W91-10766

ANALYSIS OF GROUND-PROBING RADAR DATA: PREDICTIVE DECONVOLUTION, Geological Survey of Canada, Ottawa (Ontario). Terrain Sciences Div.

P. T. LaFleche, J. P. Todoeschuck, O. G. Jensen,

And A. S. Judge.

Canadian Geotechnical Journal CGJOAH, Vol. 28, No. 1, p 134-139, February 1991. 7 fig. 25 ref.

National Sciences and Engineering Research

Council of Canada Grant No. A-0048.

Descriptors: \*Canada, \*Cores, \*Data acquisition, \*Data interpretation, \*Instrumentation, \*Permafrost, \*Radar, \*Remote sensing, Dams, Data collections, Data processing, Deconvolution, Field tests, Measuring instruments, Prediction.

Recent advances in ground-probing radar instru-mentation have allowed the collection of large volumes of digital data. Such data sets are amena-ble to modern data processing techniques both to increase geological resolution and to enhance data presentation. The close similarity between groundradar data and seismic data suggests that processing techniques that have been used in the seismic industry could be applied to radar data. The tailings pond at the Echo Bay Mines Limited Lupin mine, near Contwoyto Lake, Northwest Territories, employs several small frozen-core contain-ment dams to enclose a small watershed and to retain the mine tailings fluid. The freezing of the interiors of the dams, coupled with the underlying permafrost in the subsurface were expected to create an impermeable frozen barrier to fluid flow. During the summer of 1986, ground-probing radar surveys were conducted over several of the dams where tailings water was seeping into the sur-rounding environment. A ground-probing radar profile was deconvolved using the common prediction-error filter, which assumes a white power spectrum for the reflections, and a filter that assumes a spectrum proportional to spatial frequency. The results of the study revealed that the prediction-error filter found three of four buried presuction-error filter found three of four buried pipes which had not been visible in the undecon-volved section. All four pipes were found with the use of a second filter. (Korn-PTT) W91-10782

DETERMINISTIC COMPUTER-AIDED OPTI-MUM DESIGN OF ROCK RUBBLE-MOUND BREAKWATER CROSS-SECTIONS.

BREARWAIER CROSS-SECTIONS.
Department of Civil Engineering, City Management Amsterdam, Wibautstraat 3, 1091 GH, Amsterdam, The Netherlands.
For primary bibliographic entry see Field 8A.
W91-10785

TESTING OF CELLULAR CONCRETE REVET-MENT BLOCKS RESISTANT TO GROWTHS OF REYNOUTRIA JAPONICA HOUTT (JAPA-NESE KNOTWEED).

University Coll., Cardiff (Wales). School of Pure and Applied Biology.

For primary bibliographic entry see Field 8F. W91-10942

DEEP-SEATED CONSOLIDATION SETTLE-MENTS IN THE FRASER RIVER DELTA. British Columbia Univ., Vancouver. Dept. of Civil

Engineering. For primary bibliographic entry see Field 8D. W91-10948

METHOD OF CALCULATING THE TECHNO-LOGICAL PARAMETERS WHEN DESIGNING HYDRAULIC-FILL DAMS OF SILTY SOILS. For primary bibliographic entry see Field 8A. W91-11284

#### 8I. Fisheries Engineering

CHANGE OF OCEANIC CONDITION BY THE MAN-MADE STRUCTURE FOR UPWELLING. Ehime Univ., Matsuyama (Japan). Dept. of Ocean

Engineering.
T. Yanagi, and M. Nakajima.
Marine Pollution Bulletin MPNBAZ, Vol. 23, p 131-135, 1991. 7 fig, 2 tab, 2 ref.

Descriptors: \*Coastal waters, \*Control structures, \*Ecological effects, \*Fisheries, \*Japan, \*Marine fisheries, \*Upwelling, Chlorophyll a, Flow rates, Nutrient concentrations, Population dynamics, Sea walls, Seto Inland Sea, Zooplankton.

The development of coastal fisheries has been an important priority in Japan. Changes of oceanic conditions as a result of a man-made structure (MARITEX) for upwelling were investigated in Bungo Channel, in the Seto Inland Sea, Japan. The structure, 10 m high and 20 m wide, was set 50 m below the ocean surface in order to induce upwelling at the eastern part of the Bungo Channel in the autumn of 1987. Intensive field observations were carried out before and after the installation of the carried out before and after the installation of the structure. Nutrients, chlorophyll a and the biomass of zooplankton increased after the structure's installation. Net flow, averaged over fifteen days was directed to the southeast with a speed of about 15 cm/sec, and was not changed by the installation fMARITEX. The number of species and population size decreased after the MARITEX installation, but average hold vize increased. Long-terms of the structure of t tion, but average body size increased. Long-term investigations are needed to assess the impact over time. (Brunone-PTT)

BENTHIC FAUNAL SUCCESSION IN A COVE ORGANICALLY POLLUTED BY FISH FARM-

Kumamoto Women's University, Mizuarai 2432-1, Kengun-machi, Kumamoto, 862 Japan. For primary bibliographic entry see Field 5C. W91-10554

STRATEGIES FOR RESTORING AND DEVEL-OPING FISH HABITATS IN THE STRAIT OF GEORGIA: PUGET SOUND INLAND SEA, NORTHEAST PACIFIC OCEAN.

Department of Fisheries and Oceans, Vancouver (British Columbia). West Vancouver Lab. For primary bibliographic entry see Field 5G. W91-10568

PACIFIC SALMON AT THE CROSSROADS: STOCKS AT RISK FROM CALIFORNIA, OREGON, IDAHO, AND WASHINGTON.

W. Nehlsen, J. E. Williams, and J. A. Lichatowich. Fisheries (Bethesda) FISHDN, Vol. 16, No. 2, p 4-21, March/April 1991. 2 tab, 81 ref.

Descriptors: "California, "Endangered species, "Fish management, "Idaho, "Oregon, "Salmon, Species composition, "Washington, Agriculture, Fish conservation, Fish hatcheries, Habitat restoration, Habitats, Hydroelectric power.

The American Fisheries Society herein provides a list of depleted Pacific salmon, steelhead, and searun cutthroat stocks from California, Oregon, Idaho, and Washington, to accompany the list of rare inland fishes reported previously. The list includes 214 native naturally-spawning stocks: 101 at high risk of extinction, 58 at moderate risk of as ingir iss of special concern, and one classified as threatened under the Endangered Species Act of 1973 and as endangered by the state of Califor-nia. The decline in native salmon, steelhead, and nia. In decline in native samon, steelnead, and sea-run cutthroat populations has resulted from habitat loss and damage, and inadequate passage and flows caused by hydropower, agriculture, log-ging, and other developments; overfishing, primar-ily of weaker stocks in mixed-stock fisheries; and negative interactions with other fishes, including nonnative hatchery salmon and steelhead. While nonnative nationery samon and steelnead. While some attempts at remedying these threats have been made, they have not been enough to prevent the broad decline of stocks along the West Coast. A new paradigm that advances habitat restoration and ecosystem function rather than hatchery production is needed for many of these stocks to survive and prosper into the next century. (Authoric abstract) thor's abstract)

AQUATIC HABITAT MEASUREMENT AND VALUATION: IMPUTING SOCIAL BENEFITS TO INSTREAM FLOW LEVELS.

National Ecology Research Center, Fort Collins,

Co.

For primary bibliographic entry see Field 7C. W91-11266

HYDRAULICS OF CULVERT FISHWAYS IV: SPOILER BAFFLE CULVERT FISHWAYS. Alberta Univ., Edmonton, Dept. of Civil Engi-

N. Rajaratnam, C. Katopodis, and S. Lodewyk. Canadian Journal of Civil Engineering CJCEB8, Vol. 18, No. 1, p 76-82, February 1991. 13 fig, 1 tab, 8 ref.

Descriptors: \*Culvert fishways, \*Fish passages, \*Hydraulics, Comparison studies, Design criteria, Performance evaluation, Spoiler baffles, Weirs.

A culvert with special provisions to make it passable by fish is referred to as a culvert fishway. Several devices have been developed to improve the fish-passing capacity of culverts. An experimental study was conducted on the hydraulics of culvert fishways with spoiler baffles. Four designs were studied with heights of the baffles equal to 0.99D and 0.15D and longitudinal spacings of 0.53D and 1.06D, where D is the diameter of the culvert. Design equations were developed relating culvert. Design equations were developed relating the flow depth to the flow rate, diameter, and slope of the culvert for each baffle design. Expres-sions also were found for the barrier velocity. Two sions also were found for the barrier velocity. Two designs, both using alternating sets of three and four baffles, were quite effective in providing larger depths in the pools between baffles and reduced barrier velocities at the baffles. Compared to simpler baffle systems (e.g., weir), the spoiler baffle system would be more expensive to install, unless the baffle plates were installed during the construction of the culvert itself. (Rochester-PTT) W91-11279

ASSESSING STREAM VALUES: PERSPEC-TIVES OF AQUATIC RESOURCE PROFES-SIONALS.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Fisheries and Wildlife Sciences. P. L. Angermeier, R. J. Neves, and L. A. Nielsen. North American Journal of Fisheries Management NAJMDP, Vol. 11, No. 1, p 1-10, Winter 1991. 2 fig, 2 tab, 45 ref.

Descriptors: \*Fisheries, \*Professional personnel, \*Resources management, \*Streams, Decision making, Environmental policy, Regression analysis, Species diversity, Virginia.

A multiattribute judgment technique was used to identify features of streams and rivers that confer

Specialized Information Center Services—Group 10D

ecological and fishery values as perceived by aquatic resource professionals. Four groups of pro-fessionals were surveyed: (1) fishery managers fessionals were surveyed: (1) fishery managers from Virginia's fisheries management agency; (2) aquatic biologists from Virginia's water quality regulation agency; (3) fishery managers from throughout the USA; and (4) fish ecologists from throughout the USA. Each professional assigned scores indicating value to a series of hypothetical streams that varied on the basis of six predetermined factors: species richness, importance to rare or endemic species, percent of habitat modified, water quality, percent of riparian zone forested, and fish abundance. Multiple linear regression was used to examine relationships between the varying factors and the value scores assigned by professionfactors and the value scores assigned by profession-als. Importance to rare and endemic species and species richness were major determinants of pereived ecological value, whereas fishery value was ceived ecological value, whereas fishery value was largely determined by species composition, aesthetic quality, and fish size. Although value perspectives were generally similar among groups of professionals, perspectives of fishery value were more discordant than perspectives of ecological value. It is suspected that variation in fisheries managers' views of fishery-related value results from the lark of a cohesive framework for fisheries. managers' views of fishery-related value results from the lack of a cohesive framework for fisheries management policy. This work illustrates how analytical techniques developed in the social sciences may help fishery managers assign priorities among their research and management activities. Converting implicit knowledge into explicit policy criteria can improve efficiency and public acceptance of management strategies. (Medina-PTT) W91-11425

# PRODUCTION OF CHIRONOMID LARVAE IN CULTURING MEDIA OF VARIOUS ORGANIC WASTES,

Kalyani Univ. (India). Dept. of Zoology.

B. B. Jana, and G. P. Pal. Limnologica LMNOA8, Vol. 21, No. 1, p 281-285, October 1990. 2 fig, 2 tab, 18 ref.

Descriptors: \*Culture media, \*Fish farming, \*Fish Food, \*Midges, \*Waste utilization, Animal wastes, Aquatic insects, Biomass, Carbon, Cattle, Food chains, Food-processing wastes, Larval growth stage, Manure, Nitrogen, Population density, Poultry, Productivity, Rice.

Various organic wastes were examined as media for the secondary production of chironomia larvae, which form an important link in the food chain of many cultivable fishes. Estimates of population number, biomass, and production of three size classes of chironomid larvae were obtained size classes of chironomid larvae were obtained from culturing media comprising mustard oil cake, nohua oil cake, cow dung, poultry waste, and rice bran. The large, medium, and small size classes occurred in maximal numbers in mustard oil cake, rice bran, and poultry waste, respectively. Monthly mean production (P) ranged from 5.4 to 10.0 g/sq m, while total biomass (B) varied between 5.7 and 15.8 g/sq m. Among the culture media, the average P/B coefficient was highest for pond water (1.3) and lowest for mustard oil cake (0.42). The high level of production in the rice bran medium may be due to its higher C/N ratio (prepared aquadte medium 2.43, dry manure 23.0) than the other culture media. Because of the dominance of small and medium-sized individuals in the cow dung medium, a relatively total low biomass was dung medium, a relatively total low biomass was expected in this medium compared with the others. The percent distribution of the three size classes of chironomid populations leads to a similar conclusion. Since production in the rice bran, cow dung, and poultry waste media was markedly higher than in the others, the former media seem to be most useful for mass production of chironomid larvae. (Doria-PTT) W91-11526

# QUALITY OF SALMONID HATCHERY EF-FLUENTS DURING A SUMMER LOW-FLOW SEASON.

Washington State Dept. of Ecology, Olympia. For primary bibliographic entry see Field 5D. W91-11532

# HABITAT USE BY AN ASSEMBLAGE OF FISH IN A LARGE WARMWATER STREAM,

Virginia Polytechnic Inst. and State Univ., Blacks-burg. Dept. of Fisheries and Wildlife Sciences. For primary bibliographic entry see Field 2H. W91-11533

DISTRIBUTION, HABITAT USE, AND GROWTH OF AGE-0 COLORADO SQUAW-FISH IN THE GREEN RIVER BASIN, COLO-RADO AND UTAH.

Fish and Wildlife Service, Vernal, UT. For primary bibliographic entry see Field 2H. W91-11534

# ESTIMATION OF SPORT FISH HARVEST FOR RISK AND HAZARD ASSESSMENT OF ENVIRONMENTAL CONTAMINANTS.

Battelle Pacific Northwest Labs., Richland, WA. For primary bibliographic entry see Field 5G. W91-11556

# MODELS OF SEASONAL GROWTH OF THE EQUATORIAL CARP LABEO DUSSUMIERI IN RESPONSE TO THE RIVER FLOOD CYCLE.

Colombo Univ. (Sri Lanka). Dept. of Zoology. For primary bibliographic entry see Field 2H. W91-11559

# REVIEW OF FISHERIES HABITAT IMPROVE-MENT PROJECTS IN WARMWATER STREAMS, WITH RECOMMENDATIONS FOR WISCONSIN.

Wisconsin Dept. of Natural Resources, Madison. Bureau of Fish Management. For primary bibliographic entry see Field 2H. W91-11591

### 9. MANPOWER, GRANTS AND FACILITIES

#### 9A. Education (Extramural)

PROFESSIONALISM IN AGRICULTURE: SEEKING A TRAINING STANDARD. For primary bibliographic entry see Field 5G. W91-11198

# DEVELOPING A GROUNDWATER TRAINING PROGRAM FOR PESTICIDE USERS.

For primary bibliographic entry see Field 5G. W91-11199

MARYLAND'S TRAIN-THE-TRAINER PRO-GRAM HOUSEHOLD HAZARDOUS WASTE. For primary bibliographic entry see Field 5G. W91-11200

# FARM BUREAU'S GROUNDWATER AND EN-VIRONMENTAL QUALITY SELF-HELP CHECKLIST FOR FARMSTEADS AND FARM FIELDS.

For primary bibliographic entry see Field 5G. W91-11201

# FLORIDA'S PESTICIDE WATER QUALITY EDUCATION PROGRAM.

Florida Univ., Gainesville. Dept. of Soil Science. For primary bibliographic entry see Field 5G. W91-11202

# 10, SCIENTIFIC AND TECHNICAL INFORMATION

### 10C. Secondary Publication And Distribution

WATERSHED DEVELOPMENT IN ASIA: STRATEGIES AND TECHNOLOGIES. For primary bibliographic entry see Field 6B.

SOIL AND MOISTURE CONSERVATION TECHNOLOGIES: REVIEW OF LITERATURE. International Bank for Reconstruction and Development, Washington, DC. Agriculture Div. For primary bibliographic entry see Field 4D. W91-11565

### 10D. Specialized Information Center Services

ESTABLISHMENT OF A GROUNDWATER RE-SEARCH DATA CENTER FOR VALIDATION OF SUBSURFACE FLOW AND TRANSPORT MODELS.

Butler Univ., Indianapolis, IN. Holcomb Research

For primary bibliographic entry see Field 2F. W91-10736

# OVERVIEW OF U.S. GEOLOGICAL SURVEY WATER-RESOURCES INFORMATION PRO-GRAMS.

N. Lopez.

IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p 87-91, 1 tab, 2 ref.

Descriptors: \*Groundwater quality, \*Information Descriptors: "Croundwater quanty, "Information systems, "Nonpoint pollution sources, "US Geological Survey, Agricultural chemicals, Data storage and retrieval, Geochemistry, Geohydrology, National Water Quality Assessment Progra, Regional Aquifer System Analysis, Research.

The Geological Survey maintains the largest single source of groundwater resources and related earth science information in the United States. Much of this information comes from the various selected activities of the Water Resources Division of the devines of the water accounts Division of the Geological Survey. The Regional Aquifer Systems Analysis (RASA) Program has produced more than 600 reports, hydrologic investigations atlases, and scientific articles between 1978 and 1988 on 14 and scientific arricles between 1978 and 1986 on 14 of the 28 aquifer systems originally identified for study. The National Water Quality Assessment Program (NAWQA), begun in 1986, is designed to define the current status of water quality and to identify and evaluate changes in it. The National Research Program is organized into six major research disciplings, water chamistry, anotheristic than the control of the program o search disciplines: water chemistry, geochemistry, groundwater hydrology, surface-water hydrology, geomorphology and sediment transport, and cology. The research program supports all other activigy. The research program supports an other activi-ties of the Survey and supports related work in other organizations. A major objective of this pro-gram is research on the fate and transport of natu-ral and man-made contaminants, especially agricul-tural chemicals, in groundwater. The Geological Survey maintains all data on their mainframe computer in Reston. Information is transferred to dis-trict offices by telecommunications. (See also W91-11162) (Rubinstein-PTT) in Reston. Information is transferred to dis-

# PESTICIDES AND DRINKING WATER INFOR-MATION: A PERSPECTIVE FROM EPA'S NA-TIONAL PESTICIDE SURVEY.

For primary bibliographic entry see Field 5D. W91-11173

#### Field 10—SCIENTIFIC AND TECHNICAL INFORMATION

#### **Group 10D—Specialized Information Center Services**

AGRISOURCE: THE INFORMATION SYSTEM FOR CROP TECHNOLOGY. REACH/AgriSource, Cenex/Land O'Lakes, PO Box 64089, St. Paul, MN 55164-0089. J. S. Ahlrichs.

J. S. Aniricas.
IN: Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management. Freshwater Foundation, Navarre, Minnesota. 1989. p. 353-355.

Descriptors: \*Agricultural chemicals, \*Agriculture, \*Computers, \*Hazardous materials, \*Information systems, \*Nonpoint pollution sources, \*Water pollution prevention, Computer programs, Data processing, Databases, Decision making.

AgriSource is a communication and information system for crop technology developed by Cenex/Land O'Lakes, a large regional farm cooperative. It was developed on the foundation that numerous information providers are trying, sometimes with limited success, to get agronomic information to fertilizer and chemical dealers and farmers in a fertilizer and chemical dealers and farmers in a timely manner. It was also developed on the foundation that these groups often cannot get the up-to-date information they need when they need it. Agronomists and other decision makers at fertilizer and chemical dealerships are the primary influence affecting a farmer's or other end user's product application and use decisions. These decision makers are the true target audience of most government, industry, university and extension personnel. AgriSource provides an easy way to directly reach this target audience each day. With the AgriSource communication network, Cenex/Land O'Lakes has gone to primary information suppliers (chemical companies, soil test labs, government and industry) and arranged for them to enter their information in a standard, organized format. A computer is installed at each information supplier to enter and maintain their database. Fertilizer and computer is installed at each information supplier to enter and maintain their database. Fertilizer and chemical dealers and other professionals needing timely and up-to-date agronomic information subscribe to these databases. Each night a personal computer located at Cenex/Land O'Lakes updates and sorts new information provided by the information supplier. To install AgriSource the user must provide a computer while Cenex/Land O'Lakes provides all of the AgriSource programs and databases. (See also W91-11162) (Korn-PTT) W91-11196

DIRECTORY OF MEMBER ORGANIZATIONS OF THE NATIONAL WATER DATA EX-CHANGE (NAWDEX). Geological Survey, Reston, VA. Water Resources

C. D. Blackwell.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 90-141, 1990. 81p,

Descriptors: \*Directories, \*National Water Data Exchange, Data storage and retrieval, Institutions, Networks.

Networks.

The National Water Data Exchange (NAWDEX) is a national program to assist users of water data or water-related data in identifying, locating, and acquiring needed data. A variety of data, indexing, assistance and referral services are provided through a nationwide network of Assistance Centers located in 45 States and Puerto Rico. The program is centrally managed and coordinated by a NAWDEX Program Office located within the US Geological Survey in Reston, Virginia. NAWDEX is a national confederation consisting of member organizations from all sectors of the water data community including Federal, State, local governmental, academic, interstate, and private organizations. Foreign organizations are also invited to become affiliated with the program. This Directory provides the names, addresses, and telephone numbers of all NAWDEX member organizations and their designated NAWDEX representatives. (See also W91-11575) (Lantz-PTT)

DIRECTORY OF ASSISTANCE CENTERS OF THE NATIONAL WATER DATA EXCHANGE (NAWDEX).

Geological Survey, Reston, VA. Water Resources C. D. Blackwell.

Available from Books and Open Files Reports Section, USGS Box 25425, Denver, CO 80225. USGS Open File Report 90-142, 1990. 37p,

Descriptors: \*Directories, \*National Water Data Exchange, Data storage and retrieval, Institutions, Networks.

The National Water Data Exchange (NAWDEX) is a nationwide program managed by the US Geological Survey (USGS) to assist users of water data or water-related data in identifying, locating, and acquiring needed data. NAWDEX is a confederation of water oriented organizations working to tion of water oriented organizations working to-gether to make their data more readily accessible and to facilitate a more efficient exchange of water data. NAWDEX services are available through a Program Office located at the USG's National Center in Reston, Virginia, and a nationwide net-work of Assistance Centers located in 45 States, the District of Columbia and Puerto Rico to pro-vide local and convenient access to NAWDEX facilities. This Directory provides the names of organizations and persons to contact, addresses, organizations and persons to contact, addresses, telephone numbers, and the various types of data and services available at each location. (See also W91-11574) (Lantz-PTT) W91-11575

# 10F. Preparation Of Reviews

ACID PRECIPITATION: A REVIEW. Dow Chemical U.S.A., Midland, MI. Dept. of Environmental Quality. For primary bibliographic entry see Field 5B. W91-11074

APPROACHES TO THE SIMULATION OF RE-GIONAL CLIMATE CHANGE: A REVIEW. National Center for Atmospheric Research, Boulder, CO. For primary bibliographic entry see Field 5C. W91-11427

# SUBJECT INDEX

ABANDONED WELLS Northwest Kansas Groundwater Management	Statistical Analysis of Errors in Estimating Wet Deposition Using Five Surface Estimation Algo-	Variation in the Acidity of Ground and Surface Waters in Northern Ireland.
District No. 4. An Abandoned Well Program.	rithms.	W91-11407 2H
W91-11188 5G	W91-10474 7B	History of Cladocera in the Kleiner Barsch-See,
ACCRETION	Dry Deposition Washoff from Forest Tree	an Acidic, Calcium-Poor, Marshy Pond in the
Sediment Transport on the Foreshore. W91-10599 2L	Leaves by Experimental Acid Rainfall. W91-10476 5B	Middle European Flatland (Die Geschichte der Cladocerenfauna des Kleinen Barsch-Sees, eines
		Sauren, Kalkarmen Moorweihers im Mitteleuro-
ACETATES Removal of Acetate from NSSC Sulphite Pulp	Properties of Linear Programming Models for Acid Rain Abatement.	paischen Flachland). W91-11515 2H
Mill Condensates Using Thermophilic Bacteria.	W91-10477 5G	
W91-10889 5D	Research on Clouds and Precipitation: Past,	Assessing the Response of Emerald Lake, an Alpine Watershed in Sequoia National Park,
ACETIC ACID	Present and Future, Part II.	California, to Acidification during Snowmelt by
Analysis of Halogenated Acetic Acids in Dutch	W91-10481 3B	Using a Simple Hydrochemical Model.
Drinking Water. W91-10938 5F	Species Composition of Fish Communities in	W91-11594 5C
	Northern Wisconsin Lakes: Relation to pH.	ACID RAIN EFFECTS
ACETONE Fate of Acetone in an Outdoor Model Stream	W91-10725 5C	Dry Deposition Washoff from Forest Tree Leaves by Experimental Acid Rainfall.
with a Nitrate Supplement, Southern Mississippi,	Acid-Base Status of Pennsylvania Streams: Re-	W91-10476 5E
U.S.A.	sults from the National Stream Survey. W91-10726 5B	Interannual Variability in Acidic Deposition on
W91-10903 5B		the Mt. Mitchell Area Forest.
Transport and Fate of Acetone in an Outdoor	Ozone, Acidic Precipitation, and Soil Mg Ef- fects on Growth and Nutrition of Loblolly Pine	W91-10478 5E
Model Stream, Stennis Space Center near Bay St. Louis, Mississippi.	Seedlings.	Effects of pH and Aluminum on the Growth of
W91-11103 5B	W91-10918 5C	the Acidophilic Diatom Asterionella ralfsii var. americana.
ACID LAKES	Humic Substances in Acid Surface Waters;	W91-10862 2H
Effects of pH and Aluminum on the Growth of	Modelling Aluminium Binding, Contribution to	Hydrogeochemical Processes Controlling Sub-
the Acidophilic Diatom Asterionella ralfsii var.	Ionic Charge-Balance, and Control of pH. W91-10933 5C	surface Transport from an Upper Subcatchmen
americana. W91-10862 2H		of Walker Branch Watershed During Storm
	Environmental Problems and Solutions: Green- house Effect, Acid Rain, Pollution.	Events. 1. Hydrologic Transport Processes. W91-10907
History of Cladocera in the Kleiner Barsch-See, an Acidic, Calcium-Poor, Marshy Pond in the	W91-11066 5B	
Middle European Flatland (Die Geschichte der	Acid Precipitation: A Review.	Hydrogeochemical Processes Controlling Sub surface Transport from an Upper Subcatchmen
Cladocerenfauna des Kleinen Barsch-Sees, eines	W91-11074 5B	of Walker Branch Watershed During Storm
Sauren, Kalkarmen Moorweihers im Mitteleuro- paischen Flachland).	Chemical Composition of Individual Starms as a	Events. 2. Solute Transport Processes. W91-10908 51
W91-11515 2H	Chemical Composition of Individual Storms as a Function of Air Parcel Trajectories for the Pre-	
Analysis of Subfossil Shelled Protozoa in the	diction of Acid Rain Characteristics.	Effects of Drought Stress and Simulated Acidi Rain on Foliar Conductance of Zea mays L
Sediments of a Small Acid Forest Lake (Kleiner	W91-11075 5B	W91-10919 50
Barsch-See, Northern GDR) (Analyse Subfos- siler Protozoenschalen der Sedimente eines	Effects of Acid Rain on Epiphytic Orchid	Acid Precipitation: A Review.
Kleinen Sauren Waldsees) (Kleiner Barsch-See,	Growth. W91-11076 5C	W91-11074 51
Nordliche DDR).		Effects of Acid Rain on Epiphytic Orchi
W91-11516 2H	Utility Planning Model for the Study of Air Pollution Reduction.	Growth.
Chemical Composition of Late- and Post-Glacial	W91-11079 5G	W91-11076 56
Sediments (Fe, Mn, P, C, N, N, H and BSi) in Lake Kleiner Barsch-See, a Bog Lake in the	Executive Summary-Assessing the Response of	Executive Summary-Assessing the Response of
North of GDR (Die Chemische Zusammenset-	Emerald Lake, An Alpine Watershed in Sequoia	Emerald Lake, An Alpine Watershed in Sequoi National Park, California, to Acidification
zung der Spat- und Postglazialsedimente des Kleinen Barsch-Sees (Fe, Mn, P, C, N, H und	National Park, California, to Acidification	During Snowmelt Using a Simple Hydrochem
BSi), eines Dystrophen Moorweihers im Norden	During Snowmelt Using a Simple Hydrochemi- cal Model.	cal Model.
der DDR).	W91-11112 7C	W91-11112 7
W91-11518 2H	Rainwater and Throughfall Chemistry in a	Kinetics of Chemical Weathering in B Horizo
ACID NEUTRALIZING CAPACITY	'Terre Firme' Rain Forest: Central Amazonia.	Spodosol Fraction. W91-11233
Stream Chemistry in the Eastern United States: 2. Current Sources of Acidity in Acidic and	W91-11218 2B	Stream Chemistry in the Eastern United State
Low Acid-Neutralizing Capacity Streams.	Subice Layering and Origin of Acidic Waters in	1. Synoptic Survey Design, Acid-Base Statu
W91-11242 5B	a Small Boreal Lake During the Spring Runoff. W91-11229 5B	and Regional Patterns.
ACID RAIN		W91-11241 5
Uncertainty Analysis for a Linear Programming	Kinetics of Chemical Weathering in B Horizon Spodosol Fraction.	Chemical and Biological Factors Affecting Act
Model for Acid Rain Abatement. W91-10470 7C	Spodosol Fraction. W91-11233 5C	Tolerance of Smallmouth Bass. W91-11530 5
Increased Precipitation Acidity in the Central Sierra Nevada.	Stream Chemistry in the Eastern United States: 1. Synoptic Survey Design, Acid-Base Status,	Sensitivity of Greenback Cutthroat Trout Acidic pH and Elevated Aluminum.
W91-10471 5B	and Regional Patterns.	W91-11531 5
Analysis of Precipitation Chemistry Measure-	W91-11241 5B	ACID STREAMS
ments in Shimane, Japan.	Sequential Sampling of Particles, Major Ions and	Acid-Base Status of Pennsylvania Streams: R
W91-10472 2B	Total Trace Metals in Wet Deposition. W91-11249 5B	sults from the National Stream Survey. W91-10726
Impact of Changing Regional Emissions on Pre-		
cipitation Chemistry in the Eastern United States.	Major Ions in Marine Rainwater With Attention to Sources of Alkaline and Acidic Species.	Design of Economic and Efficient Treatme Station for Acidic Streams.
W01 10473 5G	W91-11250 SB	W91-11077 5

# ACID STREAMS

Stream Chemistry in the Eastern United States:	Purge and Trap Capillary GC-MS and by	ADRIATIC SEA
<ol> <li>Synoptic Survey Design, Acid-Base Status, and Regional Patterns.</li> </ol>	Heated Purge and Trap GC-FID. W91-11336 5A	Impact of Nutrient Enrichment and Their Rela- tion to the Algal Bloom in the Adriatic Sea.
W91-11241 5B	ACTIVATED SLUDGE	W91-10544 5C
Stream Chemistry in the Eastern United States:	Biodegradation of Benzene and a BTX Mixture	C
2. Current Sources of Acidity in Acidic and	Using Immobilized Activated Sludge.	Conceptual Framework of Environmental Man-
Low Acid-Neutralizing Capacity Streams.	W91-11381 5D	agement Strategies for Yugoslavia: The Case of the Adriatic Sea.
W91-11242 5B	ACTIVATED SLUDGE PROCESS	W91-10584 5G
ACIDIC WATER	Comparative Study on Adsorption Mechanisms	1171-10001
Modification of Benthic Community Structure	of RNA-F-Specific Coliphages and Poliovirus in	Seasonal Variations of Aliphatic Hydrocarbons
in Response to Acid-Iron Wastes Discharge.	Activated Sludge Process.	in Sardina pilchardus (Walb.) (Teleostei: Clupei-
W91-10869 5C	W91-10694 5D	dae) Tissues.
In	Influence of Reactor Mixing Characteristics on	W91-10839 5B
Impact of Titanium Dioxide Waste on Fertiliza- tion in the Sea Urchin Echinometra mathaei.	the Rate of Nitrification in the Activated Sludge	ADSORBENTS
W91-10870 5C	Process.	Thermocatalytic and Chemical Treatment of
	W91-10932 5D	Lignin-Aluminium Sludge and Utilization of the
Humic Substances in Acid Surface Waters;	Evaluation of Full Scale Activated Sludge Sys-	Resulting Adsorbent-Coagulant.
Modelling Aluminium Binding, Contribution to Ionic Charge-Balance, and Control of pH.	tems Utilizing Powdered Activated Carbon Ad-	W91-11503 5D
W91-10933 5C	dition with Wet Air Regeneration. W91-11099 5D	ADSORPTION
	W91-11099	Adsorption of Viruses by Diatomaceous Earth
ACIDIFICATION	Modeling the Upflow Anaerobic Sludge Bed-	Coated with Metallic Oxides and Metallic Per-
Acid-Base Status of Pennsylvania Streams: Re- sults from the National Stream Survey.	Filter System: a Case with Hysteresis.	oxides.
W91-10726 5B	W91-11321 5D	W91-10659 5A
	Foaming in Activated Sludge Plants: A Survey	Colour Removal from Textile Effluents by Ad-
Executive Summary-Assessing the Response of	in Queensland, Australia and an Evaluation of	sorption Techniques.
Emerald Lake, An Alpine Watershed in Sequoia National Park, California, to Acidification	Some Control Strategies. W91-11328 5D	W91-11323 5D
During Snowmelt Using a Simple Hydrochemi-	W91-11326	
cal Model.	Comparison of Alternative Operating Modes on	ADVANCED WASTEWATER TREATMENT
W91-11112 7C	the Halifax Activated-Sludge Plant.	Design of Sewage-Treatment Plants in Brisbane, Australia.
Subice Layering and Origin of Acidic Waters in	W91-11359 5D	W91-11361 5D
a Small Boreal Lake During the Spring Runoff.	Design of Sewage-Treatment Plants in Brisbane,	***************************************
W91-11229 5B	Australia.	ADVECTION
	W91-11361 5D	Boundary Element and Particle Tracking Model
Variation in the Acidity of Ground and Surface Waters in Northern Ireland.	Activated Sludge Process to Reduce the Pollu-	for Advective Transport in Zoned Aquifers.
W91-11407 2H	tion Load of a Dye-Industry Waste.	W91-10997 2F
	W91-11455 5D	AERATED LAGOONS
Analysis of Subfossil Shelled Protozoa in the	Treatment of Pulp-Bleaching Effluents by Acti-	Treatability of Bleached Kraft Pulp and Paper
Sediments of a Small Acid Forest Lake (Kleiner Barsch-See, Northern GDR) (Analyse Subfos-	vated Sludge, Precipitation, Ozonation and Irra-	Mill Wastewaters In a New Zealand Aerated
siler Protozoenschalen der Sedimente eines	diation.	Lagoon Treatment System.
Kleinen Sauren Waldsees) (Kleiner Barsch-See,	W91-11491 5D	W91-11499 5D
Nordliche DDR).	Criteria for Nutrient-Balanced Operation of Ac-	AERATION
W91-11516 2H	tivated Sludge Process.	Bubbleless Aeration.
Diatom Analysis, Late-Glacial and Post-Glacial	W91-11493 5D	W91-11222 5G
Development of Lake Kleiner Barsch-See	Nitrogen and Phosphorus Limits for Nutrient	Evaluation Associan Technology for Baden Ba
(GDR)-A Preliminary Note.	Deficient Industrial Wastewaters.	Evaluating Aeration Technology for Radon Re- moval.
W91-11517 2H	W91-11494 5D	W91-11462 5F
Assessing the Response of Emerald Lake, an	Conductivity for Nutrient Control In CTMP	***************************************
Alpine Watershed in Sequoia National Park,	Wastewater Treatment.	AERIAL PHOTOGRAPHY
California, to Acidification during Snowmelt by	W91-11495 5D	ARCHIMEDES IIa Experiment on Oil Slick
Using a Simple Hydrochemical Model. W91-11594 5C	Factors Affecting the Removal and Discharge	Detection over the North SeaApril 1988 Measurement Results Obtained by the E-SAR
W91-11394	of Organic Chlorine Compounds at Activated	System of the German Aerospace Research Es-
ACIDITY	Sludge Treatment Plants.	tablishment.
Variation in the Acidity of Ground and Surface	W91-11498 5D	W91-10742 5B
Waters in Northern Ireland. W91-11407 2H	Activated Sludge Treatment of Kraft Mill Ef-	
W91-11407 2H	fluents from Conventional and Oxygen Bleach-	AEROBIC DIGESTION
Chemical and Biological Factors Affecting Acid	ing.	Aerobic Thermophilic Digestion of Pre-Thick- ened Sludge Using Air.
Tolerance of Smallmouth Bass.	W91-11511 5D	W91-10704 5D
W91-11530 5C	Pre-hydrolyzed Aluminum Hydroxide and Iron	
ACIDS	Hydroxide in Activated Sludge Treatment.	Thermophilic Aerobic Stabilisation.
Analysis of Halogenated Acetic Acids in Dutch	W91-11539 5D	W91-11134 5D
Drinking Water.	ADMINISTRATIVE AGENCIES	Aerobic-Thermophilic Methods for Disinfecting
W91-10938 5F	Soil Conservation Service and Extension: Coop-	and Stabilizing Sludge.
ACOUSTICS	erating to Enhance Services (MES Portion).	W91-11143 5D
Acoustic Parametric Array for Measuring the	W91-11170 6E	O-I- FILID- AD-AT
Thickness and Stratigraphy of Contaminated	Funding Groundwater Protection Programs:	Oxic Fluidized-Bed Treatment of Dichlorophen- ols.
Sediments.	Iowa's Groundwater Protection Fund.	ois. W91-11485 5D
W91-10981 2J	W91-11179 5G	
ACRYLONITRILE	Wisconsin's Risk Assessment Based Numerical	Treatment of Bleaching Effluents In Aerobic/
Quantitative Determination of Acrylonitrile in	Groundwater Standards Program.	Anaerobic Fluidized Biofilm Systems.
an Industrial Effluent by Ambient-Temperature	W91-11183 5G	W91-11486 5D

AEROBIC TREATMENT Membrane Filtration Combined with Biological Treatment for Purification of Bleach Plant Ef-	Ground Water Contamination from Agricultural Sources: Implications for Voluntary Policy Adherence from Iowa and Virginia Farmer's Atti-	Climatic Change and Future Agroclimatic Potential in Europe. W91-10970 2B
fluents.	tudes.	Micro-Targeting Cropland Retirement for
W91-11490 5D	W91-11437 5G	Water Quality Improvement: Measuring the
Aerobic and Anaerobic Biofiltration in an Aqua- culture UnitNitrite Accumulation as a Result of Nitrification and Denitrification.	AGRICULTURAL ENGINEERING Economic Analysis of Soil Conservation Technologies.	Benefits of Increased Information. W91-11052 3F
W91-11547 5D	W91-11566 4D	Sludge Recycling in Agriculture Compared with
AEROMONAS	AGRICULTURAL PRACTICES	Other Disposal Methods in France. W91-11137 5E
Enumeration of Motile Aeromonas in Valencia Coastal Waters by Membrane Filtration.	FACTA 1990 Conservation and Environmental	Examples of Agricultural Use of Residual
W91-10636 5B	Highlights. W91-10507 5G	Sludge. W91-11139 5D
Effectivity of Chlorine Dioxide to Control Aer-	Methods of Applying Sewage Sludge to Land:	
omonas in Drinking Water Distribution Systems. W91-10677 5F	A Review of Recent Developments.  W91-11119  5E	Use of Sewage Sludge on Agricultural Land: Impact on Soil Fauna. W91-11150 5E
Chlorine Resistance of Motile Aeromonas spp.	Agrichemicals and Ground Water: Assumptions	
W91-10678 5F	about Farmer Information Processes.	Existing Conditions for Agricultural Utilization of Sewage Sludge Compost in Japan.
Aeromonas Species Stabilization Ponds in the Arid Region of Marrakesh, Morocco, and Rela-	W91-11163 6B	W91-11152 5E
tion to Fecal-Pollution and Climatic Factors. W91-10842 5D	Communicating with Farmers: Providing Useful and Reliable Sources of Information.	Chemical Properties of Sewage Sludges Produced in the Valencian Area (Spain).
	W91-11164 5G	W91-11159 5A
AEROSOLS  Efficiency With Which Drizzle and Precipita-	National Program for Soil and Water Conserva-	Funding New York State's Integrated Pest Man-
tion Sized Drops Collide With Aerosol Particles. W91-11252 2B	tion. Its Effect on USDA Services. W91-11169 3F	agement Program. W91-11180 6C
	Com Date Management Systems Inc. Martins	
Aerosol and Hydrometeor Concentrations and Their Chemical Composition During Winter	Crop Data Management Systems, Inc. Meeting California's Pesticide Regulation Challenge.	AgriSource: The Information System for Crop Technology.
Precipitation Along a Mountain Slope: III. Size-	W91-11177 5G	W91-11196 10D
Differentiated In-Cloud Scavenging Efficiencies. W91-11253 2B	Ground Water Contamination from Agricultural	Farmer-Initiated Project to Promote Sustainable
AFRICA	Sources: Implications for Voluntary Policy Ad- herence from Iowa and Virginia Farmer's Atti-	Agriculture in Cooperation with the Extension Service.
Correlated Oceanic and Continental Records	tudes.	W91-11203 3F
Demonstrate Past Climate and Hydrology of	W91-11437 5G	AGRONOMY
North Africa (0-140 ka). W91-10788 2B	AGRICULTURAL RUNOFF	Agronomic Effects of Land Application of
AGRICULTURAL CHEMICALS	Nitrate Removal by Denitrification in Alluvial Ground Water: Role of a Former Channel.	Water Treatment Sludges. W91-11459 4C
Agrichemicals and Groundwater Protection:	W91-10909 5B	
Resources and Strategies for State and Local Management.	Economic Analysis of Soil Conservation Tech-	AIR FLOTATION Removal of Humic Substances and Algae by
W91-11162 5G	nologies.	Dissolved Air Flotation.
Communicating with Farmers: Providing Useful	W91-11566 4D	W91-10751 5F
and Reliable Sources of Information.	Assessment of Agricultural Nutrient Point	AIR POLLUTION
W91-11164 5G	Source Discharge from Tile Drains, Spring and Overland Runoff from Two Farms, Dauphin	Relationship Between Mean and Standard Devi- ation in Precipitation Chemistry Measurements
Emerging Issues at the Intersection of Agricul- tural and Environmental Policy.	County, Pennsylvania. W91-11600 5B	Across Eastern North America. W91-10475 2B
W91-11165 5G		
Planned Studies of Agrichemicals in Ground	AGRICULTURAL WATER FACTA 1990 Conservation and Environmental	Evidence of Chernobyl Fallout on a Temperate Himalayan Glacier.
and Surface Water in the Mid-Continental	Highlights.	W91-10950 5B
United States. W91-11168 5B	W91-10507 5G	Atmospheric Carbon Dioxide and the Global
National Pesticide Usage Data Base.	Adoption of Water-Savings Practices by Irriga-	Carbon Cycle: The Key Uncertainties.
W91-11176 7C	tors in the High Plains. W91-10821 3F	W91-11068 5B
AgriSource: The Information System for Crop		Ambient Air Co-Modeling in Alaska. W91-11070 7C
Technology.	Economic Assessment of the Water Quality Ben- efits of Conservation Tillage on Southwestern	
W91-11196 10D	Ontario Cropland.	Effects of Land Use Alteration on Tropical Carbon Exchange.
Professionalism in Agriculture: Seeking a Train- ing Standard.	W91-11050 3F	W91-11072 4C
W91-11198 5G	AGRICULTURAL WATERSHEDS Non-Point Source Loadings of Nutrients and	Utility Planning Model for the Study of Air Pollution Reduction.
Farm Bureau's Groundwater and Environmental Quality Self-Help Checklist for Farmsteads and	Dissolved Organic Carbon from an Agricultural- Suburban Watershed in East Central Florida.	W91-11079 5G
Farm Fields.	W91-10927 5B	Stream Chemistry in the Eastern United States:
W91-11201 5G	Soil and Moisture Conservation Technologies:	<ol> <li>Synoptic Survey Design, Acid-Base Status, and Regional Patterns.</li> </ol>
Strategies for Nonprofit Organizations for Pre-	Review of Literature. W91-11565 4D	W91-11241 5B
venting Agrichemical Contamination of Ground Water.		Air Quality and Deposition of Trace Elements in
W91-11204 5G	AGRICULTURE Effect of Long-Term Application of Fertilizers	the Province of South-Holland. W91-11248 5B
In the Land of the Giants: Grassroots Organiz-	on the Agrophysical Properties of an Irrigated	
ing in California's Central Valley. W91-11205 5G	Light-Chestnut Soil. W91-10914 2G	Hong Kong: Can the Dragon Clean its Nest. W91-11439 5G

# AIR POLLUTION CONTROL

AIR POLLUTION CONTROL Properties of Linear Programming Models for Acid Rain Abatement. W91-10477 5G	ALASKA Secchi Disk and Photometer Estimates of Light Regimes in Alaskan Lakes: Effects of Yellow Color and Turbidity.	Identity of Suspended Particles in a Calcite- Depositing Stream and Their Significance in Trapping and Binding Phenomena. W91-11522 2E
	W91-10860 2H	W91-11522 2E
Utility Planning Model for the Study of Air Pollution Reduction. W91-11079 5G	Ambient Air Co-Modeling in Alaska. W91-11070 7C	ALGAL BLOOMS  Effect of a Spring Phytoplankton Bloom on Dissolved Copper Speciation in Bedford Basin.
Mathematical Modelling for Sulphur Dioxide		W91-10543 5B
Removal from Stack Gases in a Fluidized Bed of Activated Sodium Carbonate.  W91-11080 5G	ALBERTA Milk River: Historical Transitions in an Interna- tional Waterway. W91-11039 6E	Impact of Nutrient Enrichment and Their Rela- tion to the Algal Bloom in the Adriatic Sea.
AIR POLLUTION EFFECTS	ALCOHOLS	W91-10544 5C
Ozone, Acidic Precipitation, and Soil Mg Effects on Growth and Nutrition of Loblolly Pine Seedlings.	Transport and Fate of Acetone in an Outdoor Model Stream, Stennis Space Center near Bay St. Louis, Mississippi.	Life Cycle Strategies of the Red Tide Causing Flagellates Chattonella (Raphidophyceae) in the Seto Inland Sea.
W91-10918 5C	W91-11103 5B	W91-10546 5B
Environmental Problems and Solutions: Green-	ALDICARB	Bloom of Coscinodiscus wailesii and DO Deficit
house Effect, Acid Rain, Pollution. W91-11066 5B	Home Water Treatment: Remediating Aldicarb Contamination in Suffolk County, New York.	of Bottom Water in Seto Inland Sea. W91-10549 5C
Observational and Theoretical Studies of Green-	W91-11189 5F	Long Term Ecological Changes in the Gulf of
house Climate Effects.	ALEXANDRIA	Thailand.
W91-11067 5C	Incidence and Ecology of Marine Fouling Orga-	W91-10551 5B
Challenge of Sustaining Productivity in the Face	nisms in the Eastern Harbour of Alexandria, Egypt.	ALGAL GROWTH
of CO2-Induced Change.	W91-10560 5C	Macroalgal-Sediment Nutrient Interactions and
W91-11073 5C	ALGAE	Their Importance to Macroalgal Nutrition in a
AIR POLLUTION SOURCES Environmental Problems and Solutions: Green-	Macroalgal-Sediment Nutrient Interactions and Their Importance to Macroalgal Nutrition in a	Eutrophic Estuary. W91-10497 2L
house Effect, Acid Rain, Pollution. W91-11066 5B	Eutrophic Estuary. W91-10497 2L	Growth Potentials of Red Tide Phytoplankters in Coastal Seawater by AGP Assay.
Uncertainty in the Projection of Carbon Dioxide	Construction of Artificial Seaweed Bed Accom-	W91-10548 5A
Emissions. W91-11069 5B	panied with the Reclamation for Unit No. 3 of Ikata Power Station.	Simulation of Bioecological and Water Quality Processes in Enclosed Coastal Seas.
Chemical Composition of Individual Storms as a	W91-10603 2L	W91-10557 5C
Function of Air Parcel Trajectories for the Pre- diction of Acid Rain Characteristics.	Removal of Humic Substances and Algae by	Local and Seasonal Variation of the Epipelic
W91-11075 5B	Dissolved Air Flotation. W91-10751 5F	Algae in Samarra Impoundment, Iraq.
Radon in Homes Following Its Reduction in a		W91-11525 2H
Community Water Supply. W91-11464 5B	Inhibition of NO3(-), NH4(+), and PO4(3-) Uptake in Anabaena doliolum Exposed to a Petroleum Oil.	ALGAL JELLIES Proximate Composition and Nutrient Elements
AIR QUALITY	W91-10825 5C	in the Unusual Algal Jellies of Lake Oguta in Southern Nigeria.
Ambient Air Co-Modeling in Alaska. W91-11070 7C	Annual Bacterial Production in Relation to Benthic Microalgal Production and Sediment	W91-11408 2H
AIR STRIPPING	Oxygen Uptake in an intertidal Sandflat and an	ALGAL PHYSIOLOGY
Computer Modeling of Scale Formation During Treatment of Ground Water in Air Strippers.	Intertidal Mudflat. W91-10865 2L	Inhibition of NO3(-), NH4(+), and PO4(3-) Uptake in Anabaena doliolum Exposed to a Pe- troleum Oil.
W91-10798 5G	Microcystis Changes its Buoyancy in Response	W91-10825 5C
AIR TEMPERATURE	to the Average Irradiance in the Surface Mixed	
Some Updated Statistical Assessments of the Surface Temperature Response to Increased	Layer. W91-10895 2H	Trace Metal Interactions with Marine Phyto- plankton.
Greenhouse Gases. W91-10969 2B	Ecophysiological Significance of the Diel Bio-	W91-10853 2L
	chemical Changes of Particulates Coupled with Metabolic and Environmental Parameters in	ALGICIDES
Relation of Atmospheric CO2 to Tropical Sea and Air Temperatures and Precipitation. W91-11002 2B	Two Trophically Different Lakes. W91-10896 2H	Algicidal and Chemical Effect of u.vRadiation of Water Containing Humic Substances. W91-10941 5F
Observational and Theoretical Studies of Green-	Role of Phosphorus Cycling in Algal Metabo-	
house Climate Effects. W91-11067 5C	lism and Algal Succession in Lake Donghu, China.	ALGORITHMS Fast Algorithm for Automatically Computing
AIRPORTS	W91-10897 5C	Strahler Stream Order. W91-10818 2J
Kansai International Airport Project and Envi- ronmental Impact Assessment. W91-10563 4C	Comparative Study and Mathematical Modeling of Temperature, Light and Growth of Three Microalgae Potentially Useful for Wastewater	Optimal Data Acquisition Strategy for the Development of a Transport Model for Ground-
	Treatment.	water Remediation.
ALABAMA Kinematic, Dynamic, and Thermodynamic	W91-10937 5D	W91-11238 5G
Analysis of a Weakly Sheared Severe Thunder- storm over Northern Alabama.	1-Naphthalenesulfonic acid and Sulfate as Sulfur Sources for the Green Alga Scenedesmus obli-	Risk-based Performance Criteria for Real-time Reservoir Operation.
W91-11417 2B	quus.	W91-11275 4A
Ground-Water Flow and Stream-Aquifer Rela- tions in the Northern Coastal Plain of Georgia and Adjacent Parts of Alabama and South Caro-	W91-11326 5D  Regulatory Influence of Water Current on Algal Colonization in an Unshaded Stream at Shillong	ALIPHATIC HYDROCARBONS Seasonal Variations of Aliphatic Hydrocarbons in Sardina pilchardus (Walb.) (Teleostei: Clupei-
lina.	(Meghalaya, India).	dae) Tissues.
W91-11598 2F	W91-11451 2E	W91-10839 5B

ALKALINITY	Impact of Carbon Dioxide and Ammonium on	Coliform Bacteria in Drinking Water from
Role of Seasonal Turnover in Lake Alkalinity Dynamics.	the Growth of Submerged Sphagnum cuspida- tum.	South Bavaria: Identification by the API 20E-
W91-10861 2H	W91-11452 2H	System and Resistance Patterns. W91-10627 5F
ALLUVIAL AQUIFERS		
Rhine Rift Valley Groundwater-River Interac-	AMPHIPODS  Germanic Acellus Petio es en Index of Organia	Determination of Subnanomolar Levels of Iron(II) and Total Dissolved Iron in Seawater
tions: Evolution of their Susceptibility to Pollu-	Gammarus: Asellus Ratio as an Index of Organic Pollution.	by Flow Injection Analysis with Chemilumines-
tion.	W91-11331 5A	cence Detection.
W91-10849 5B	AN A EBODIC CONDETIONS	W91-10773 2K
ALLUVIAL PLAINS	ANAEROBIC CONDITIONS  Anaerobic Treatability of a Phenolic Coal Con-	Spectrophotometric Determination of Nitrite in
Nitrate Removal by Denitrification in Alluvial	version Wastewater After Diisopropyl Ether	Polluted Waters Using 3-Nitroaniline.
Ground Water: Role of a Former Channel. W91-10909 5B	Extraction.	W91-10823 5A
	W91-10939 5D	
ALPINE REGIONS	ANAEROBIC DIGESTION	Simultaneous Ultraviolet Spectrophotometric Determination of Nitrate and Nitrite in Water.
Diel Oxygen Cycle in Three Subalpine Swiss Streams.	Accumulation of Refractory 4-Nonylphenol	W91-10824 5A
W91-10899 2H	During Mesophilic Anaerobic Sludge Stabiliza-	
ALTITUDE	tion.	Studies of Dissolved Carbohydrates (or Carbohydrate-Like Substances) in an Estuarine Envi-
Variation of the Stable Isotopes of Water with	W91-10707 5D	ronment.
Altitude in the Saint Elias Mountains of Canada.	Fate and Effects of Semivolatile Organic Pollut-	W91-10840 2L
W91-11220 2C	ants During Anaerobic Digestion of Sludge.	
ALUMINUM	W91-10884 5D	Rapid Preconcentration Method for Multiele- ment Analysis of Natural Freshwaters.
Effects of pH and Aluminum on the Growth of	Modeling the Upflow Anaerobic Sludge Bed-	W91-10892 7E
the Acidophilic Diatom Asterionella ralfsii var. americana.	Filter System: a Case with Hysteresis.	
W91-10862 2H	W91-11321 5D	Determination of Chlorinated Phenoxy Acid
Humin Cubetaness in Asid Surface Waters	Closing Paper Mill Whitewater Circuits by In-	and Ester Herbicides in Soil and Water by Liquid Chromatography Particle Beam Mass
Humic Substances in Acid Surface Waters; Modelling Aluminium Binding, Contribution to	serting an Anaerobic Stage with Subsequent	Spectrometry and Ultraviolet Absorption Spec
Ionic Charge-Balance, and Control of pH.	Treatment.	trophotometry.
W91-10933 5C	W91-11477 5G	W91-10893 5.A
Variation in the Acidity of Ground and Surface	Future Perspectives for the Anaerobic Treat-	Chromatographic Separation of Arsenic Specie
Waters in Northern Ireland.	ment of Forest Industry Wastewaters.	with Sodium Bis(trifluoroethyl)dithiocarbamat
W91-11407 2H	W91-11478 5D	Chelation.
Sensitivity of Greenback Cutthroat Trout to	Anaerobic Toxicity of Fines In Chemi-thermo-	W91-10894
Acidic pH and Elevated Aluminum.	mechanical Pulp Wastewaters: A Batch Assay-	Sensitive High-Performance Liquid Chromato
W91-11531 5C	Reactor Study Comparison. W91-11479 5D	graphic Analysis for Toxicological Studies with
Pre-hydrolyzed Aluminum Hydroxide and Iron	W91-114/9	Carbaryl.
Hydroxide in Activated Sludge Treatment.	Anaerobic Biodegradability and Methanogenic	W91-10920 5/
W91-11539 5D	Toxicity of Pulping Wastewaters. W91-11480 5D	Voltammetric Determination of the Complexe
AMAZON RIVER BASIN	W91-11480 5D	tion Parameters of Zinc in Marine and Estuarin
Dams and Sustainable Development in Brazilian Amazonia.	Treatment of Bleaching Effluents In Aerobic/	Waters. W91-10924 21
W91-11216 8C	Anaerobic Fluidized Biofilm Systems.	W 91-10924
	W91-11486 5D	Measurement of the Different Forms of Zinc i
Rainwater and Throughfall Chemistry in a 'Terre Firme' Rain Forest: Central Amazonia.	Investigation of Anaerobic Removal and Degra-	Narragansett Bay Water Based on the Rate of
W91-11218 2B	dation of Organic Chlorine from Kraft Bleach-	Uptake by a Chelating Resin. W91-10926 21
Mente	ing Wastewaters. W91-11492 5D	
AMEBAS Interrelations Between Amoebae and Bacteria in		Development of an Enzyme Immunoassay for
the Moselle River, France.	Anaerobic Treatment of Bleached TMP and	the Determination of Metazachlor. W91-11295 5.
W91-10650 5B	CTMP Effluent In the BioPAQ UASB System. W91-11501 5D	W91-11293
AMINES	W91-11501 5D	Preconcentration of Hydrophilic and Hydrophic
Determination of Nitroaromatics and Nitramines	Anaerobic Degradation of PCP and Phenol In	bic Pesticides from Aqueous Solutions and Extraction of Residues Using the Polymeric So.
in Ground and Drinking Water by Wide-Bore	Fixed-Film Reactors: The Influence of an Addi-	bent Wofatit Y 77.
Capillary Gas Chromatography. W91-11262 5A	tional Substrate. W91-11512 5D	W91-11305 5
AMMONIA  Ambient Water Quality Criteria for Ammonia	Aerobic and Anaerobic Biofiltration in an Aqua-	Comparison of Amperometric and UV-Spectro photometric Monitoring in the HPLC Analys
(Saltwater)-1989.	culture Unit-Nitrite Accumulation as a Result of Nitrification and Denitrification.	of Pesticides.
W91-10750 5G	W91-11547 5D	W91-11306 5.
Model of Ammonia Volatilization From Applied	AND AND ONLY THE APPLICATE	Multi-Residue-Analysis of Pesticides by HPL
Urea. V. The Effects of Steady-State Drainage	ANAEROBIC TREATMENT  Effect of NSSC Spent Liquor on Granule For-	after Solid Phase Extraction.
and Evaporation.	mation and Specific Microbial Activities In	W91-11307 · 5.
W91-10805 3F	Upflow Anaerobic Reactors.	Application of UDI C Calama Caritala in D
Model of Ammonia Volatilization From Applied	W91-11482 5D	Application of HPLC Column-Switching in Pe ticide Residue Analysis.
Urea. VI. The Effects of Transient-State Water	Thermophilic Anaerobic Treatment of Sulfate-	W91-11308 5
Evaporation. W91-10806 3F	Rich Pulp and Paper Integrate Process Water.	
	W91-11483 5D	Multimethod for Pesticides in Soil at Tra- Level.
AMMONIUM Leaching of Ammonium Nitrate under Field	ANALYTICAL METHODS	W91-11309 5
Conditions: Studies on Kinetics of Nitrification	Production and Control of Reference Materials	
and Nitrate Reduction in an Ultisol Profile.	for Water Microbiology.	Analysis of 10 Selected Herbicides in Water
W91-10999 5B	W91-10623 5A	W91-11311 5

# ANALYTICAL METHODS

Strategy for Pesticide Control in Ground Water and Drinking Water. W91-11312 5A	ANOXIC CONDITIONS Formation of Oxygen-Deficient Water Mass in	Distribution, Habitat Use, and Growth of Age-0 Colorado Squawfish in the Green River Basin, Colorado and Utah.
	Omura Bay. W91-10592 5B	W91-11534 2H
Solid-Phase Extraction for Multi-Residue Analy- sis of Some Triazole and Pyrimidine Pesticides	Flow Control Technology for Enhancement and	AQUATIC LIFE
in Water.	Diverse Use of the Marine Environment.	Processing of Leaves of Trees and Aquatic Ma-
W91-11313 5A	W91-10607 2L	crophytes in the Network of the River Rhone. W91-11402 2H
Simple Spectrophotometric Determination of	ANTIFOULANTS	
Endosulfan in River Water and Soil. W91-11314 5A	Bioaccumulation, Elimination and Metabolism of Triphenyltin Chloride by Early Life Stages of	Usefulness of Various Numerical Methods for Assessing the Specific Effects of Pollution on
Behavior of the Fungicide MBAMT in Water.	Minnows Phoxinus phoxinus.	Aquatic Biota.
W91-11315 5A	W91-10877 5B	W91-11406 5C
New Standards for the Determination of Geos-	Organotin Stability During Storage of Marine	AQUATIC ORGANISMS
min and Methylisoborneol in Water by Gas	Waters and Sediments. W91-11255 5A	Utility Planning Model for the Study of Air Pollution Reduction.
Chromatography/Mass Spectroscopy. W91-11329 5A		W91-11079 5G
	Phenyltins in Water, Sediment, and Biota of Freshwater Marinas.	AQUATIC PLANTS
Low Cost Flow Injection Analysis for Cadmium Using 2-(2-benzothiazolylazo) -4,5-Dimethyl-	W91-11342 5B	Sewage Treatment with Plants.
phenol.	AOSHIO PHENOMENON	W91-11466 5D
W91-11379 5A	Field Survey and Hydraulic Study of 'Aoshio' in	AQUATIC WEED CONTROL
High-Performance Liquid Chromatographic	Tokyo Bay.	Use of Non-Persistent Herbicides, Glyphosate,
Study on Oxidation Products of Lignin and	W91-10529 5C	and 2,4-D Amine, to Control Riparian Stands of
Humic Substances.	AQUACULTURE	Japanese Knotweed (Reynoutria japonica Houtt).
W91-11513 5A	Mariculture and Eutrophication in Jinhae Bay,	W91-10852 4A
ANALYTICAL TECHNIQUES	Korea.	
Determination of Subnanomolar Levels of	W91-10558 5B	AQUATIC WEEDS
Iron(II) and Total Dissolved Iron in Seawater	Aerobic and Anaerobic Biofiltration in an Aqua-	Temperatures Lethal to Salvinia molesta Mitch- ell.
by Flow Injection Analysis with Chemilumines- cence Detection.	culture Unit-Nitrite Accumulation as a Result	W91-11450 2H
W91-10773 2K	of Nitrification and Denitrification.	AOUIFER CHARACTERISTICS
O ded Day to the State Indian	W91-11547 5D	Method to Determine the Formation Constants
Quantitative Determination of Acrylonitrile in an Industrial Effluent by Ambient-Temperature	Design and Performance of the BIOFISH Water	of Leaky Aquifers, and Its Application to Pump-
Purge and Trap Capillary GC-MS and by	Recirculation System.	ing Test Data.
Heated Purge and Trap GC-FID.	W91-11548 5D	W91-10961 7C
W91-11336 5A	AQUATIC ANIMALS	Aquifers in the Benin Formation (Miocene-
ANIMAL GROWTH	Alternating Dynamics of Rotifers and Daphnia	Recent), Eastern Niger Delta, Nigeria: Lithos-
Effects of Linear Alkylbenzene Sulphonate (LAS) on Skeletal Development of Sea Urchin	magna in a Shallow Lake. W91-10898 2H	tratigraphy, Hydraulics, and Water Quality. W91-11443
Embryos (Paracentrotus lividus LMK). W91-10891 5C	Effects of Copper and Tributyltin on Stress Pro- tein Abundance in the Rotifer Brachionus plica-	AQUIFER MANAGEMENT Relationship of Regional Water Quality to Aqui-
ANIMAL WASTES	tilis.	fer Thermal Energy Storage.
Dutch Approach to Manure Processing.	W91-10900 5C	W91-11082 5C
W91-10703 5D	AQUATIC BACTERIA	AQUIFER PROPERTIES
Seasonal Changes in the Sanitary Bacterial Qual-	Growth and Inactivation Kinetics of Mycobac-	Delineation of Traveltime-Related Capture
ity of Water Draining a Small Upland Catch- ment in the Yorkshire Dales.	teria in Biofilms. W91-10642 5B	Areas of Wells Using Analytical Flow Models and Particle-Tracking Analysis.
W91-10935 5B		W91-10957 2F
	Microbial Mats in Tidal Channels at San Carlos,	AQUIFER RESTORATION
ANION EXCHANGE Selective Concentration of Lead(II) Chloride	Baja California Sur, Mexico. W91-11400 2L	Analytical Modeling of Aquifer Decontamina-
Complex With Liquid Anion-Exchange Mem-		tion by Pumping When Transport is Affected by
branes.	AQUATIC ENVIRONMENT	Rate-Limited Sorption.
W91-11247 5D	Electrolytic Model System for Reductive Deha- logenation in Aqueous Environments.	W91-11235 5G
ANIONS	W91-11343 5B	AQUIFER SYSTEMS
Budgets of Selected Cations and Anions in Two Forested Experimental Watersheds in Central	AQUATIC HABITATS	Contribution to the Study of the Recession Curves of Karstic Springs: Examples from
Greece.	Construction of Artificial Seaweed Bed Accom-	Greece (Contribution a l'Etude des Courses de
W91-11550 4C	panied with the Reclamation for Unit No. 3 of Ikata Power Station.	Recession des Sources Karstiques: Exemples du Pays Hellenique).
ANNUAL PRECIPITATION	W91-10603 2L	W91-10990 2F
Soil Moisture: Empirical Data and Model Re-		
sults. W91-11413 2G	Succession of Benthic Assemblages in Wild Bird Park, a Sanctuary Established on Reclaimed	Maps of the '400-foot,' '600-foot,' and Adjacent Aquifers and Confining Beds, Baton Rouge
ANNUAL RUNOFF	Land in Osaka Port. W91-10606 2L	Area, Louisiana. W91-11086 2F
Comparison of Mean Annual Runoff Estimates	W91-10606 2L	W91-11086 2F
in the Canadian Portion of the Great Lakes	Aquatic Habitat Measurement and Valuation:	Hydrogeology of the Valley-Fill Aquifer at
Basin.	Imputing Social Benefits to Instream Flow Levels.	Owego, Tioga County, New York. W91-11105 2F
W91-11020 2E	W91-11266 7C	W 21-11103 2F
Effects of Changes in Land Use on Annual		Stimulation of the Reductive Dechlorination of
Streamflows in the Lake Huron Basin of Canada and the United States.	Habitat Use by an Assemblage of Fish in a Large Warmwater Stream.	Tetrachloroethene in Anaerobic Aquifer Micro- cosms by the Addition of Toluene.
W91-11021 4C	W91-11533 2H	W91-11344 5E

Geologic Framework of the Columbia Plateau Aquifer System, Washington, Oregon, and	ARKANSAS Aquatic Macroinvertebrates of the St. Francis	ASWAN DAM Eastern Mediterranean: A Marine Desert.
Idaho. W91-11571 2F	Sunken Lands in Northeast Arkansas. W91-10844 4C	W91-10553 2H
AQUIFERS	Characterization of Padioactivity in Hot Series	ATHENS
Aquifer Restoration: Which Method.	Characterization of Radioactivity in Hot Springs National Park, Arkansas.	Spatial Distribution of Rainfall in the Greater Athens Area.
W91-10486 5G	W91-10846 2K	W91-11416 2B
Dispersal Dynamics of Groundwater Bacteria.	AROMATIC COMPOUNDS	ATLANTA
W91-10843 5B	Determination of Nitroaromatics and Nitramines in Ground and Drinking Water by Wide-Bore	Update of Flood-Flow Characteristics of Nancy Creek at Georgia Highway 400 Extension Near
Computation of Average Seasonal Groundwater	Capillary Gas Chromatography.	Atlanta, Georgia.
Flows in Phreatic Aquifer-River System. W91-10910 2F	W91-11262 5A	W91-10762 2E
	Biodegradation of Benzene and a BTX Mixture	ATLANTIC OCEAN
Analysis of Ground-Water Flow in the A-Sand Aquifer at Paramaribo, Suriname, South Amer-	Using Immobilized Activated Sludge. W91-11381 5D	Canadian Atlantic Storms Program: Progress and Plans of the Meteorological Component.
ica.		W91-10943 2B
W91-11090 2F	ARSENIC COMPOUNDS  Chromatographic Separation of Arsenic Species	ATMOSPHERIC CHEMISTRY
Denitrification in Laboratory Sand Columns: Carbon Regime, Gas Accumulation and Hy-	with Sodium Bis(trifluoroethyl)dithiocarbamate	Zonal Average Cloud Characteristics for Global
draulic Properties.	Chelation. W91-10894 5A	Atmospheric Chemistry Modelling. W91-10728 2B
W91-11330 5G	W91-10894 5A	W91-10/28 2B
Studies of Springs in the Southern Part of the	ARTIFICIAL INTELLIGENCE	Atmospheric Carbon Dioxide and the Global
Valley of Mexico (Estudio Crenologico en la	Knowledge-Based Systems and Operational Hy- drology.	Carbon Cycle: The Key Uncertainties. W91-11068 5B
Parte Meridional de la Cuenca de Mexico).	W91-11273 7C	W 21-11000
W91-11352 2E		Influence of Green Plants on the World Carbon
Channel Tunnel and Its Impact on the Folkes-	ARTIFICIAL LAKES  Estimating the Effects on the Regional Precipi-	Budget. W91-11071 2K
tone and District Water Company.	tation Climate in a Semiarid Region Caused by	
W91-11363 4C	an Artificial Lake Using a Mesoscale Model.	Chemical Composition of Individual Storms as a
Aquifers in the Benin Formation (Miocene-	W91-10502 2B	Function of Air Parcel Trajectories for the Pre- diction of Acid Rain Characteristics.
Recent), Eastern Niger Delta, Nigeria: Lithos-	ARTIFICIAL RECHARGE	W91-11075 5B
tratigraphy, Hydraulics, and Water Quality. W91-11443	Potential for Aquifer Recharge in Illinois (Ap-	ATMOCRITERIO CIRCUI ATTON
W91-11443	propriate Recharge Areas).	ATMOSPHERIC CIRCULATION Relation of Atmospheric CO2 to Tropical Sea
Potential for Aquifer Recharge in Illinois (Ap-	W91-11580 7C	and Air Temperatures and Precipitation.
propriate Recharge Areas). W91-11580 7C	ARTIFICIAL SUBSTRATES	W91-11002 2B
	Construction of Artificial Seaweed Bed Accom- panied with the Reclamation for Unit No. 3 of	ATMOSPHERIC PRESSURE
Ground-Water Flow and Stream-Aquifer Rela-	Ikata Power Station.	Response of Water Level in a Well to a Time
tions in the Northern Coastal Plain of Georgia and Adjacent Parts of Alabama and South Caro-	W91-10603 2L	Series of Atmospheric Loading Under Confined
lina.	ARTIFICIAL WETLAND TREATMENT	Conditions. W91-11236 2F
W91-11598 2F	Sewage Treatment with Plants.	
ARABIAN SEA	W91-11466 5D	ATRAZINE  Atrazine Hazards to Fish, Wildlife, and Inverte-
Effects of Oil Pollution on Bio-Ecology and	ASIA	brates: A Synoptic Review.
Fisheries on Certain Enclosed Coastal Regions	Watershed Development in Asia: Strategies and	W91-10709 5C
of Arabian Sea. W91-10555 5B	Technologies.	Statistical Characterization of Atrazine Residues
	W91-11563 6B	in Southwestern Ontario Great Lakes Tributar-
ARAL SEA  Aral Sea Basin: A Critical Environmental Zone.	Strategic Issues in Watershed Development.	ies.
W91-11441 6G	W91-11564 4D	W91-11064 5E
ARBUCKLE MOUNTAINS	Soil and Moisture Conservation Technologies:	Planned Studies of Agrichemicals in Ground and Surface Water in the Mid-Continenta
Hydrology of the Arbuckle Mountains Area,	Review of Literature. W91-11565 4D	United States.
South-Central Oklahoma.		W91-11168 5E
W91-11590 2F	Economic Analysis of Soil Conservation Tech-	AUSTRALIA
ARCHIMEDES EXPERIMENT	nologies. W91-11566 4D	Status of Eutrophication in the Great Barrier
ARCHIMEDES IIa Experiment on Oil Slick		Reef Lagoon.
Detection over the North Sea-April 1988- Measurement Results Obtained by the E-SAR	Revegetation Technologies.	W91-10535 5I
System of the German Aerospace Research Es-	W91-11568 4D	Management of the Marine Environment is
tablishment. W91-10742 5B	Land Tenure Issues in Watershed Development. W91-11569 6F	Western Australia: An Ecosystem Approach. W91-10583 50
ARGENTINA	Framework for Planning, Monitoring, and Eval-	Transferability of Water Entitlements in Austra
Features of the Limnological Behavior of Salto	uating Watershed Conservation Projects.	lia.
Grande's Reservoir (Argentina-Uruguay).	W91-11570 6B	W91-10850 6E
W91-10491 5C	ASSAY	Effect of Three Primary Treatment Sewage
ARID LANDS	Detoxification by Sephadex LH20 of Seafood	Outfalls on Metal Concentrations in the Fish
Dynamics of Non-01 Vibrio cholerae in Experi-	Concentrates for Rotavirus Assay.	Cheilodactylus fuscus Collected Along the
mental Sewage Stabilization Ponds Under Arid	W91-10696 5A	Coast of Sydney, Australia. W91-10873
Mediterranean Climate. W91-10690 5D	ASTROVIRUSES	
	Growth of Clinical Isolates of Astrovirus in a	Incidence of Legionella in the Urban Environ
Flood-Hazard Zonation in Arid Lands. W91-11390 6F	Cell Line and the Preparation of Viral RNA. W91-10669 5A	ment in Australia. W91-10929 51
W 21-11320 OF	1171-10007	

# AUSTRALIA

Salinity and Evaporation in the River Murray	Bdellovibrio sp.: A Predator under Groundwat-	Clostridium perfringens, as an Indicator Micro-
Basin, Australia.	er Conditions. A Short Communication.	organism for the Evaluation of the Effect of
W91-10989 2E	W91-10676 5B	Wastewater and Sludge Treatment Systems.
Effect of Land Development on Groundwater	Effectivity of Chlorine Dioxide to Control Aer-	W91-10686 5D
Recharge Determined from Non-Steady Chlo- ride Profiles.	omonas in Drinking Water Distribution Systems. W91-10677 5F	Salmonella Detection in Sewage Waters Using Fluorescent Antibodies.
W91-10991 4C	Chlorine Resistance of Motile Aeromonas spp.	W91-10687 5D
NOAA Satellite Data in Natural Oil Slick De- tection, Otway Basin, Southern Australia.	W91-10678 5F	Assessment of Methods for the Microbiological
W91-11296 5A	UV Disinfection of Secondary Effluents from	Analysis of Shellfish. W91-10695 5A
Design of Sewage-Treatment Plants in Brisbane,	Sewage Treatment Plants.	
Australia.	W91-10681 5D	Pulsed Field Electrophoresis of Genomic Re- striction Fragments for the Detection of Noso-
W91-11361 5D	Activity of Peracetic Acid on Sewage Indicator	comial Legionella pneumophila in Hospital
Legislative Implementation of Integrated Catch-	Bacteria and Viruses. W91-10683 5D	Water Supplies.
ment Management in Western Australia. W91-11374 6E		W91-10836 5A
	Contribution for the Study of New Pathogenic	Aeromonas Species Stabilization Ponds in the
Development of Environmental Control Legis- lation and Effluent Standards for Australasian	Indicators Removal from W. S. P. in Portugal. W91-10689 5D	Arid Region of Marrakesh, Morocco, and Rela- tion to Fecal-Pollution and Climatic Factors.
Wood Processing Industries.		W91-10842 5D
W91-11472 5G	Dynamics of Non-01 Vibrio cholerae in Experi- mental Sewage Stabilization Ponds Under Arid	Later Applytimation for the Detection of Com-
AUTOMATION	Mediterranean Climate.	Latex Agglutination for the Detection of Cam- pylobacter Species in Water.
Automatic Tracer-Dilution Method Used for	W91-10690 5D	W91-11465 5A
Stage-Discharge Ratings and Streamflow Hy- drographs on Small Iowa Streams.	Seasonal Changes in the Sanitary Bacterial Qual-	BACTERIAL GROWTH
W91-11111 7B	ity of Water Draining a Small Upland Catch-	Biodegradable Dissolved Organic Carbon
Soil Tec: A Computerized Soil-Specific Fertiliz-	ment in the Yorkshire Dales. W91-10935 5B	(BDOC) Content of Drinking Water and Poten-
er Application System.		tial Regrowth of Bacteria. W91-10630 5F
W91-11197 7C	BACTERIAL ANALYSIS	W91-10030
BACILLUS	Production and Control of Reference Materials for Water Microbiology.	Growth and Inactivation Kinetics of Mycobac-
Use of Bacillus thuringiensis var. israelensis to	W91-10623 5A	teria in Biofilms. W91-10642 5B
Control the Nuisance Fly Sylvicola fenestralis (Anisopodidae) in Sewage Filter Beds.	Surveillance Solutions to Microbiological Prob-	
W91-10890 5D	lems in Water Quality Control in Developing	UV Disinfection: Short Term Inactivation and Revival.
BACKFILL	Countries.	W91-10680 5F
Pressure of Clay Backfill against Retaining	W91-10625 5G	BACTERIAL PHYSIOLOGY
Structures. W91-10947 8D	Coliform Bacteria in Drinking Water from	Protective Effect of Glycine Betaine on Survival
	South Bavaria: Identification by the API 20E- System and Resistance Patterns.	of Escherichia coli Cells in Marine Environ-
BACKFLUSHING Use of a Backflush Technique in Cross-flow	W91-10627 5F	ments. W91-10637 5B
Microfiltration for Treating Natural Water and	Effect of Heat Shock on Recovery of Escheri-	W91-10637
Filter Backwash Wastewater in Water Works.	chia coli from Drinking Water.	Effect of Dissolved Nutrients and Inorganic Sus-
W91-11270 5F	W91-10628 5F	pended Solids on the Survival of E. coli in Seawater.
BACKWATER	Bacteriological Suitability of Water from Basrah	W91-10638 5B
Analysis of Alternative Modifications for Re- ducing Backwater Flooding at the Honey Creek	Wells for Drinking.	BACTERIAL PRODUCTIVITY
Coal Strip Mine Reclamation Site in Henry	W91-10629 5A	Annual Bacterial Production in Relation to
County, Missouri. W91-11595 2E	Study of Campylobacter in Sewage, Sewage	Benthic Microalgal Production and Sediment
	Sludge and in River Water. W91-10634 5D	Oxygen Uptake in an intertidal Sandflat and an Intertidal Mudflat.
BACKWATER FLOODS  Analysis of Alternative Modifications for Re-	W91-10034	W91-10865 2L
ducing Backwater Flooding at the Honey Creek	Relationship Between Pseudomonas aeruginosa and Bacterial Indicators in Polluted Natural	BACTERIOPHAGE
Coal Strip Mine Reclamation Site in Henry	Waters.	Virological Quality of Recreational Waters in
County, Missouri. W91-11595 2E	W91-10635 5A	the Netherlands.
	Enumeration of Motile Aeromonas in Valencia	W91-10653 5B
BACTERIA Need for New Microbiological Water Quality	Coastal Waters by Membrane Filtration.	Elimination of Coliphages, Clostridium perfrin-
Criteria.	W91-10636 5B	gens and Human Enteric Viruses During Drink- ing Water Treatment: Results of Large Volume
W91-10621 5F	Miniaturized Fluorogenic Assays for Enumera-	Samplings.
Interrelations Between Amoebae and Bacteria in	tion of E. coli and Enterococci in Marine Water.	W91-10654 5F
the Moselle River, France. W91-10650 5B	W91-10639 5A	Difficulty of Using Coliphages as 'Indicators'
	Most Probable Number Method for the Enu-	and 'Index' Organisms.
Occurrence of Male-Specific and Somatic Bac- teriophages in Polluted South African Waters.	meration of Legionella Bacteria in Water. W91-10640 5A	W91-10661 5A
W91-10662 5B		Occurrence of Male-Specific and Somatic Bac-
Field Experiments with Microbiological Tracers	Direct Detection of Enteropathogenic Bacteria in Estuarine Water Using Nucleic Acid Probes.	teriophages in Polluted South African Waters. W91-10662 5B
in a Pore Aquifer.	W91-10664 SA	7,17
W91-10673 5B	Species and Genera of Enterobacteriaceae in	Polyvalent Coliphages in Sewage.
Transport of Microorganisms in the Under-	River Neckar and After River Bank Filtration	W91-10663 5A
ground: Processes, Experiments and Simulation	and Their Resistance Patterns to Antibiotics and	Field Experiments with Microbiological Tracers
Models. W91-10674 5B	Heavy Metal Salts. W91-10675 5B	in a Pore Aquifer. W91-10673 5B
JD	1171-10013 JD	

Transport of Microorganisms in the Under- ground: Processes, Experiments and Simulation	Modern Environmental Assessment Procedures	Heavy Metal Distribution in the Godvari River Basin.
Models.	for Enclosed Seas.	W91-11445 5B
W91-10674 5B	W91-10564 6G	
F-Specific RNA Bacteriophages as Model Vi-	BASS	BEDFORD BASIN
ruses in UV Disinfection of Wastewater.	Rise and Fall of the Potomac River Striped Bass	Effect of a Spring Phytoplankton Bloom on Dissolved Copper Speciation in Bedford Basin.
W91-10682 5D	Stock: A Hypothesis of the Role of Sewage.	W91-10543 5B
Comparative Study on Adsorption Mechanisms	W91-11529 5C	
of RNA-F-Specific Coliphages and Poliovirus in	Chemical and Biological Factors Affecting Acid	BELGIUM Behavior of Heavy Metals in a Mud Flat of the
Activated Sludge Process.	Tolerance of Smallmouth Bass.	Scheldt Estuary, Belgium.
W91-10694 5D	W91-11530 5C	W91-10872 5B
Assessment of Methods for the Microbiological	BATON ROUGE	Roughness Coefficients of Watercourse Revet-
Analysis of Shellfish. W91-10695 5A	Maps of the '400-foot,' '600-foot,' and Adjacent Aquifers and Confining Beds, Baton Rouge	ted With Half-Circular Concrete Pipes. Results
W91-10093	Area, Louisiana.	of Field Measurements in Watercourse S 333 at
Bacteriophages as Model Viruses in Water Qual-	W91-11086 2F	Maarkedal.
ity Control. W91-10883 5G	BAYS	W91-11431 8B
	Effect of Coastal Sea Level Forcing on Indian	BELIZE
Coliphage and Bacteriophage as Indicators of Recreational Water Quality.	River Bay and Rehoboth Bay, Delaware.	Lessons Learned from a Third World Water and
W91-11334 5A	W91-10494 2L	Sanitation Project. W91-10503 5F
	Seasonal Variation of Biomass and Production	W 91-10303
BALTIC SEA Changes and Stress Signs in Plankton Communi-	Dynamics for Above and Belowground Compo-	BENTHIC FAUNA
ties as a Result of Man-Induced Perturbations in	nents of a Spartina alterniflora Marsh in the Euhaline Sector of Paranagua Bay (SE Brazil).	Meiofauna of an Experimental Soft Bottom Eco-
Enclosed Coastal Seas (Mediterranean, Baltic).	W91-10495 2L	systemEffects of Macrofauna and Cadmium
W91-10547 5C		Exposure. W91-10519 5C
Introduced SpeciesResource or Threat in	Outflow and Three-Dimensional Spreading of River Water in Enclosed Bay.	
Brackish-Water Seas: Examples from the Baltic	W91-10525 2L	Longitudinal Development of Macroinverte-
and Black Sea.		brate Communities Below Oligotrophic Lake Outlets.
W91-10552 2L	BDELLOVIBRIO Bdellovibrio sp.: A Predator under Groundwat-	W91-10856 2H
Integrated Management of the Baltic Sea.	er Conditions. A Short Communication.	
W91-10580 5G	W91-10676 5B	Modification of Benthic Community Structure in Response to Acid-Iron Wastes Discharge.
Heavy Metals Contamination in the Polish Zone	BEACH CONTAMINATION	W91-10869 5C
of Southern Baltic.	Man-Made Garbage Pollution on the Mediterra-	
W91-10597 5B	nean Coastline.	Short-Term Effects of a Catastrophic Beaver
Organohalogens of Natural and Industrial Origin	W91-10569 5B	Dam Collapse on a Stream Fish Community. W91-11558 2E
In Large Recipients of Bleach-Plant Effluents.	Tar Balls on Ibeno-Okposo Beach of South-East	W 91-11330
W91-11505 5B	Nigeria.	BENTHIC FLORA
Rotifers of the Genus SynchaetaAn Important	W91-10876 5B	Saprobiological Investigations on the Bottom Flora of the River Recknitz in the Northern Part
Component of the Zooplankton in the Coastal	Coliphage and Bacteriophage as Indicators of	of the Mecklenburgian Lake District (GDR)
Waters of the Southern Baltic. W91-11519 2L	Recreational Water Quality.	(Saprobiologische Untersuchungen an der
	W91-11334 5A	Benthosflora der Recknitz im Norden der Meck-
BANGLADESH	BEACH PROFILES	lenburger Seenplatte (DDR)). W91-11520 2E
Exporting Himalayan Floods. W91-11014 2E	Sediment Transport on the Foreshore. W91-10599 2L	W 71-11320
		Microzoobenthos of the River Jihlava After the
BANK EROSION September 5, 1987, Landslide on the La Grande	BEACHES	Construction of the Dalesice Waterworks. W91-11521 6G
River, James Bay, Quebec, Canada.	Use of Respiration in the Sandy Beach or on the Tidal Flat: 1. Permeable Sandy Beach.	W91-11521 6G
W91-10946 2J	W91-10541 5G	BENZENE
Channel and Bank Stability of Wolf Creek and a	S. E T	Biodegradation of Benzene and a BTX Mixture
Tributary at U.S. Highway 45 Near Wheeler,	Sediment Transport on the Foreshore. W91-10599 2L	Using Immobilized Activated Sludge. W91-11381 5D
Prentiss County, Mississippi.		
W91-11107 2E	BEAVER DAMS Short-Term Effects of a Catastrophic Beaver	BIOACCUMULATION
BANK PROTECTION	Dam Collapse on a Stream Fish Community.	Integrated Management of the Baltic Sea. W91-10580 5G
Testing of Cellular Concrete Revetment Blocks	W91-11558 2E	W 91-10380
Resistant to Growths of Reynoutria japonica	BEAVERS	Heavy Metals Contamination in the Polish Zone
Houtt (Japanese Knotweed). W91-10942 8F	226-Ra and Other Radionuclides in Water,	of Southern Baltic. W91-10597 5B
	Vegetation, and Tissues of Beavers (Castor cana-	W91-10597 5B
BANK STABILIZATION Channel and Bank Stability of Wolf Creek and a	densis) from a Watershed Containing U Tailings Near Elliot Lake, Canada.	Biochemical and Histochemical Observations on
Tributary at U.S. Highway 45 Near Wheeler,	W91-11454 5B	Effects of Low-Level Metal Load (Lead, Cad-
Prentiss County, Mississippi.		mium) in Different Organ Systems of the Fresh- water Crayfish, Astacus astacus L. (Crustacea:
W91-11107 2E	Open Channel Velocity Profiles over a Zone of	Decapoda).
BARCELONA	Rapid Infiltration.	W91-10827 5B
Volatile Organic Compounds in Two Polluted		Seasonal Variations of Aliphatic Hydrocarbons
Rivers in Barcelona (Catalonia, Spain). W91-10887 5B	Changes with Time of the Transport Rate of	in Sardina pilchardus (Walb.) (Teleostei: Clupei-
	Sediment Mixtures.	dae) Tissues.
BARNACLES  Effects of Pollution on Heterozygosity in the	W91-10988 7B	W91-10839 5B
Barnacle Balanus amphitrite (Cirripedia: Thora-		Assimilation of Metals in Marine Copepods and
cica).	Gravel Bed Streams.	its Biogeochemical Implications.
W91-10518 5C	W91-11231 2J	W91-10866 2L

# BIOACCUMULATION

Pff of The Di T S	Personal de la Water Calable Personal de Name	Distance detical of Chamiltonia Toron Comme
Effect of Three Primary Treatment Sewage Outfalls on Metal Concentrations in the Fish	Exposed to a Water Soluble Fraction of North Sea Crude Oil.	Biodegradation of Chemicals at Trace Concen- trations.
Cheilodactylus fuscus Collected Along the	W91-10871 5A	W91-11102 5B
Coast of Sydney, Australia.	W31-100/1	W 31-11104 3B
W91-10873 5B	Biodegradation of Chemicals at Trace Concen-	Biodegradation of Hydrocarbon Vapors in the
	trations.	Unsaturated Zone.
Patella vulgata, Mytilus minimus and Hyale pre-	W91-11102 5B	W91-11227 5B
vosti as Bioindicators for Pb and Se Enrichment		Florest de Madal Santon Con Badandina Data
in Alexandria Coastal Waters. W91-10875 5A	Standard Test Fish for India and the Neighbor-	Electrolytic Model System for Reductive Deha-
W91-10875 5A	ing Countries.	logenation in Aqueous Environments. W91-11343 5B
Bioaccumulation, Elimination and Metabolism of	W91-11300 5A	W91-11343 3B
Triphenyltin Chloride by Early Life Stages of	Monitoring of Organochlorine Compounds In	Microbial Dechlorination of the Herbicide Me-
Minnows Phoxinus phoxinus.	Finnish Inland Waters Polluted by Pulp and	tolachlor.
W91-10877 5B	Paper Effluents Using the Mussel Incubation	W91-11377 5B
Maraum Badu Burden and Otalish Characteria	Method.	
Mercury Body Burden and Otolith Characteris- tics of Bluefin Tuna from the Northwest Medi-	W91-11507 5A	Biodegradation of Benzene and a BTX Mixture
terranean (Balearic Sea).		Using Immobilized Activated Sludge.
W91-10881 2L	BIOAVAILABILITY	W91-11381 5D
	Bioavailability of Organic Pollutants in Boreal	Anaerobic Biodegradability and Methanogenic
Organic Substances in Soils and Plants after	Waters with Varying Levels of Dissolved Or-	Toxicity of Pulping Wastewaters.
Intensive Applications of Sewage Sludge.	ganic Material.	W91-11480 5D
W91-11126 5E	W91-10936 5B	
Concentration of Metals in Various Larval	BIOCHEMICAL OXYGEN DEMAND	Magnetite Formation During Microbial Dissimi-
Stages of Four Ephemeroptera Species.	Comparison of Pressurized and Gravity Distri-	latory Iron Reduction.
W91-11302 5B	bution Systems for Wastewater Treatment.	W91-11544 2J
	W91-10845 5D	Fate and Transport of Cadiment Associated
Bioconcentration of Chlorinated Aromatic Hy-	30	Fate and Transport of Sediment-Associated
drocarbons in Aquatic Macrophytes.	Comparison of Alternative Operating Modes on	Contaminants. W91-11587 5B
W91-11338 5B	the Halifax Activated-Sludge Plant.	W 91-11367 3B
226-Ra and Other Radionuclides in Water,	W91-11359 5D	BIOFILM REACTORS
Vegetation, and Tissues of Beavers (Castor cana-		Denitrification by Thermophilic Soil Bacteria
densis) from a Watershed Containing U Tailings	BIOCHEMICAL TESTS	With Ethanol as Substrate in a USB Reactor.
Near Elliot Lake, Canada.	Initial Evaluation of Developmental Malforma-	W91-11254 5D
W91-11454 5B	tion as an End Point in Mixture Toxicity Hazard	
W31-11434 3B	Assessment for Aquatic Vertebrates.	Treatment of Bleaching Effluents In Aerobic/
IOASSAY	W91-10832 5C	Anaerobic Fluidized Biofilm Systems.
Measurement of the Effect of Organic Pollution	Subchronic Hepatotoxicity of Selenomethionine	W91-11486 5D
on Marine Organisms: Rapid Determination of	Ingestion in Mallard Ducks.	1 1 P 1 1 1 P 1 1 1 1 P 1 1 1 1 1 1 1 1
EROD Induction Using Plate Readers.	W91-10838 5C	Anaerobic Degradation of PCP and Phenol In
W91-10469 5A	W 51-10030	Fixed-Film Reactors: The Influence of an Addi-
Mainforms of an Ermanimental Soft Battom Ess	BIOCHEMISTRY	tional Substrate.
Meiofauna of an Experimental Soft Bottom Eco- systemEffects of Macrofauna and Cadmium	Size Structure of Particulate Biogenic Silica in	W91-11512 5D
Exposure.	Lake Michigan.	BIOFILMS
W91-10519 5C	W91-10975 2H	Growth and Inactivation Kinetics of Mycobac-
W 91-10319		teria in Biofilms.
Growth Potentials of Red Tide Phytoplankters	BIOCONTROL	W91-10642 5B
in Coastal Seawater by AGP Assay.	Polyvalent Coliphages in Sewage.	
W91-10548 5A	W91-10663 5A	BIOFISH SYSTEM
Maria Ballada Biana A Mil C M II	Bdellouibeig en . A Bradatas under Granndust	Design and Performance of the BIOFISH Water
Marine Pollution Bioassay by Using Sea Urchin	Bdellovibrio sp.: A Predator under Groundwat-	Recirculation System.
Eggs in the Tanabe Bay, Wakayama Prefecture,	er Conditions. A Short Communication. W91-10676 5B	W91-11548 5D
Japan, 1970-1987. W91-10602 5A	W 91-100/6	BIOFOULING
W 91-10002	Use of Bacillus thuringiensis var. israelensis to	
Microbiological Methods for Safety Testing of	Control the Nuisance Fly Sylvicola fenestralis	Incidence and Ecology of Marine Fouling Orga- nisms in the Eastern Harbour of Alexandria,
Drinking Water Directly Reclaimed from	(Anisopodidae) in Sewage Filter Beds.	
Wastewater.	W91-10890 5D	Egypt. W91-10560 5C
W91-10613 5A		W 91-10300 SC
District District Co.	Temperatures Lethal to Salvinia molesta Mitch-	BIOGEOCHEMISTRY
Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Poten-	ell.	Assimilation of Metals in Marine Copepods and
		its Biogeochemical Implications.
	W91-11450 2H	
tial Regrowth of Bacteria.		W91-10866 2L
	BIODEGRADATION	W91-10866 2L
tial Regrowth of Bacteria. W91-10630 5F	BIODEGRADATION Biodegradable Dissolved Organic Carbon	W91-10866 2L BIOINDICATORS
tial Regrowth of Bacteria. W91-10630 5F  Detoxification by Sephadex LH20 of Seafood	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Poten-	W91-10866 2L BIOINDICATORS Measurement of the Effect of Organic Pollution
tial Regrowth of Bacteria. W91-10630 5F  Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay.	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Potential Regrowth of Bacteria.	W91-10866 2L BIOINDICATORS Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of
tial Regrowth of Bacteria. W91-10630 5F  Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay. W91-10696 5A	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Poten-	W91-10866 2L BIOINDICATORS Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers.
tial Regrowth of Bacteria.  W91-10630 5F  Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay.  W91-10696 5A  Effect of 3,4-Dichloroaniline on the Early Life	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Potential Regrowth of Bacteria.	W91-10866 2L BIOINDICATORS Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of
tial Regrowth of Bacteria. W91-10630 5F  Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay. W91-10696 5A  Effect of 3,4-Dichloroaniline on the Early Life Stages of the Zebrafish (Brachydanio rerio): Re-	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Potential Regrowth of Bacteria.  W91-10630 5F	W91-10866 2L BIOINDICATORS Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers. W91-10469 5A
tial Regrowth of Bacteria. W91-10630 5F  Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay. W91-10696 5A  Effect of 3,4-Dichloroaniline on the Early Life Stages of the Zebrafish (Brachydanio rerio): Results of a Comparative Laboratory Study.	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Potential Regrowth of Bacteria. W91-10630 5F Biotechnology Degradation and Mitigation of	W91-10866 2L  BIOINDICATORS  Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers.  W91-10469 5A  Microbiological Methods for Safety Testing of
tial Regrowth of Bacteria. W91-10630 5F  Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay. W91-10696 5A  Effect of 3,4-Dichloroaniline on the Early Life Stages of the Zebrafish (Brachydanio rerio): Re-	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Potential Regrowth of Bacteria. W91-10630 5F Biotechnology Degradation and Mitigation of Offshore Oil Spills, Phase 1. Main Report: Tech-	W91-10866 2L BIOINDICATORS Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers. W91-10469 5A
tial Regrowth of Bacteria.  W91-10630 5F  Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay.  W91-10696 5A  Effect of 3,4-Dichloroaniline on the Early Life Stages of the Zebrafish (Brachydanio rerio): Results of a Comparative Laboratory Study.  W91-10828 5A	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Potential Regrowth of Bacteria. W91-10630 5F Biotechnology Degradation and Mitigation of Offshore Oil Spills, Phase 1. Main Report: Technology to Enhance Biodegradation of Oil Spills	W91-10866 2L  BIOINDICATORS  Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers.  W91-10469 5A  Microbiological Methods for Safety Testing of Drinking Water Directly Reclaimed from
tial Regrowth of Bacteria.  W91-10630 5F  Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay.  W91-10696 5A  Effect of 3,4-Dichloroaniline on the Early Life Stages of the Zebrafish (Brachydanio rerio): Results of a Comparative Laboratory Study.  W91-10828 5A  Ultrastructural and Biochemical Effects of Cad-	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Potential Regrowth of Bacteria. W91-10630  5F Biotechnology Degradation and Mitigation of Offshore Oil Spills, Phase 1. Main Report: Technology to Enhance Biodegradation of Oil Spills State of the Art and Perspectives for Technolo-	W91-10866 2L  BIOINDICATORS  Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers. W91-10469 5A  Microbiological Methods for Safety Testing of Drinking Water Directly Reclaimed from Wastewater. W91-10613 5A
tial Regrowth of Bacteria.  W91-10630 5F  Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay.  W91-10696 5A  Effect of 3,4-Dichloroaniline on the Early Life Stages of the Zebrafish (Brachydanio rerio): Results of a Comparative Laboratory Study.  W91-10828 5A	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Potential Regrowth of Bacteria. W91-10630 5F Biotechnology Degradation and Mitigation of Offshore Oil Spills, Phase 1. Main Report: Technology to Enhance Biodegradation of Oil Spills State of the Art and Perspectives for Technology Development. W91-10735 5G	W91-10866 2L  BIOINDICATORS  Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers.  W91-10469 5A  Microbiological Methods for Safety Testing of Drinking Water Directly Reclaimed from Wastewater.  W91-10613 5A  Evaluation of Fecal Enterococci Isolation Media
tial Regrowth of Bacteria.  W91-10630 5F  Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay.  W91-10696 5A  Effect of 3,4-Dichloroaniline on the Early Life Stages of the Zebrafish (Brachydanio rerio): Results of a Comparative Laboratory Study.  W91-10828 5A  Ultrastructural and Biochemical Effects of Cadmium on the Aquatic Fern Marsilea minuta	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Potential Regrowth of Bacteria. W91-10630 5F Biotechnology Degradation and Mitigation of Offshore Oil Spills, Phase 1. Main Report: Technology to Enhance Biodegradation of Oil Spills State of the Art and Perspectives for Technology Development. W91-10735 5G Fate of Acetone in an Outdoor Model Stream	W91-10866  BIOINDICATORS  Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers.  W91-10469  Microbiological Methods for Safety Testing of Drinking Water Directly Reclaimed from Wastewater.  W91-10613  5A  Evaluation of Fecal Enterococci Isolation Media to Indicate Fecal Pollution in Chlorinated
tial Regrowth of Bacteria.  W91-10630 5F  Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay.  W91-10696 5A  Effect of 3,4-Dichloroaniline on the Early Life Stages of the Zebrafish (Brachydanio rerio): Results of a Comparative Laboratory Study.  W91-10828 5A  Ultrastructural and Biochemical Effects of Cadmium on the Aquatic Fern Marsilea minuta Linn.  W91-10829 5C	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Potential Regrowth of Bacteria. W91-10630 5F Biotechnology Degradation and Mitigation of Offshore Oil Spills, Phase 1. Main Report: Technology to Enhance Biodegradation of Oil Spills State of the Art and Perspectives for Technology Development. W91-10735 5G Fate of Acetone in an Outdoor Model Stream with a Nitrate Supplement, Southern Mississippi,	W91-10866  BIOINDICATORS  Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers. W91-10469  Microbiological Methods for Safety Testing of Drinking Water Directly Reclaimed from Wastewater. W91-10613  Evaluation of Fecal Enterococci Isolation Media to Indicate Fecal Pollution in Chlorinated Water.
tial Regrowth of Bacteria.  W91-10630 5F  Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay.  W91-10696 5A  Effect of 3,4-Dichloroaniline on the Early Life Stages of the Zebrafish (Brachydanio rerio): Results of a Comparative Laboratory Study.  W91-10828 5A  Ultrastructural and Biochemical Effects of Cadmium on the Aquatic Fern Marsilea minuta Linn.  W91-10829 5C  Ecotoxicological Effects Assessment: A Com-	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Potential Regrowth of Bacteria. W91-10630 5F Biotechnology Degradation and Mitigation of Offshore Oil Spills, Phase 1. Main Report: Technology to Enhance Biodegradation of Oil Spills State of the Art and Perspectives for Technology Development. W91-10735 5G Fate of Acetone in an Outdoor Model Stream with a Nitrate Supplement, Southern Mississippi, U.S.A.	W91-10866  BIOINDICATORS  Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers.  W91-10469  Microbiological Methods for Safety Testing of Drinking Water Directly Reclaimed from Wastewater.  W91-10613  5A  Evaluation of Fecal Enterococci Isolation Media to Indicate Fecal Pollution in Chlorinated
tial Regrowth of Bacteria.  W91-10630  Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay.  W91-10696  SA  Effect of 3,4-Dichloroaniline on the Early Life Stages of the Zebrafish (Brachydanio rerio): Results of a Comparative Laboratory Study.  W91-10828  SA  Ultrastructural and Biochemical Effects of Cadmium on the Aquatic Fern Marsilea minuta Linn.  W91-10829  SC  Ecotoxicological Effects Assessment: A Comparison of Several Extrapolation Procedures.	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Potential Regrowth of Bacteria. W91-10630 5F Biotechnology Degradation and Mitigation of Offshore Oil Spills, Phase 1. Main Report: Technology to Enhance Biodegradation of Oil Spills State of the Art and Perspectives for Technology Development. W91-10735 5G Fate of Acetone in an Outdoor Model Stream with a Nitrate Supplement, Southern Mississippi,	W91-10866  BIOINDICATORS  Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers.  W91-10469  Microbiological Methods for Safety Testing of Drinking Water Directly Reclaimed from Wastewater.  W91-10613  5A  Evaluation of Fecal Enterococci Isolation Media to Indicate Fecal Pollution in Chlorinated Water.  W91-10626  5F
tial Regrowth of Bacteria.  W91-10630 5F  Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay.  W91-10696 5A  Effect of 3,4-Dichloroaniline on the Early Life Stages of the Zebrafish (Brachydanio rerio): Results of a Comparative Laboratory Study.  W91-10828 5A  Ultrastructural and Biochemical Effects of Cadmium on the Aquatic Fern Marsilea minuta Linn.  W91-10829 5C  Ecotoxicological Effects Assessment: A Com-	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Potential Regrowth of Bacteria. W91-10630 5F Biotechnology Degradation and Mitigation of Offshore Oil Spills, Phase 1. Main Report: Technology to Enhance Biodegradation of Oil Spills State of the Art and Perspectives for Technology Development. W91-10735 5G Fate of Acetone in an Outdoor Model Stream with a Nitrate Supplement, Southern Mississippi, U.S.A. W91-10903 5B	W91-10866  BIOINDICATORS  Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers. W91-10469  Microbiological Methods for Safety Testing of Drinking Water Directly Reclaimed from Wastewater. W91-10613  5A  Evaluation of Fecal Enterococci Isolation Media to Indicate Fecal Pollution in Chlorinated Water. W91-10626  Relationship Between Pseudomonas aeruginosa
tial Regrowth of Bacteria.  W91-10630 5F  Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay.  W91-10696 5A  Effect of 3,4-Dichloroaniline on the Early Life Stages of the Zebrafish (Brachydanio rerio): Results of a Comparative Laboratory Study.  W91-10828 5A  Ultrastructural and Biochemical Effects of Cadmium on the Aquatic Fern Marsilea minuta Linn.  W91-10829 5C  Ecotoxicological Effects Assessment: A Comparison of Several Extrapolation Procedures.  W91-10830 5A	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Potential Regrowth of Bacteria. W91-10630 5F Biotechnology Degradation and Mitigation of Offshore Oil Spills, Phase 1. Main Report: Technology to Enhance Biodegradation of Oil Spills State of the Art and Perspectives for Technology Development. W91-10735 5G Fate of Acetone in an Outdoor Model Stream with a Nitrate Supplement, Southern Mississippi, U.S.A. W91-10903 5B Transformation of (C-14)-2,4-Dichlorophenol in	W91-10866 2L  BIOINDICATORS  Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers.  W91-10469 5A  Microbiological Methods for Safety Testing of Drinking Water Directly Reclaimed from Wastewater.  W91-10613 5A  Evaluation of Fecal Enterococci Isolation Media to Indicate Fecal Pollution in Chlorinated Water.  W91-10626 5F  Relationship Between Pseudomonas aeruginosa and Bacterial Indicators in Polluted Natural
tial Regrowth of Bacteria.  W91-10630  Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay.  W91-10696  SA  Effect of 3,4-Dichloroaniline on the Early Life Stages of the Zebrafish (Brachydanio rerio): Results of a Comparative Laboratory Study.  W91-10828  SA  Ultrastructural and Biochemical Effects of Cadmium on the Aquatic Fern Marsilea minuta Linn.  W91-10829  SC  Ecotoxicological Effects Assessment: A Comparison of Several Extrapolation Procedures.	BIODEGRADATION Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Potential Regrowth of Bacteria. W91-10630 5F Biotechnology Degradation and Mitigation of Offshore Oil Spills, Phase 1. Main Report: Technology to Enhance Biodegradation of Oil Spills State of the Art and Perspectives for Technology Development. W91-10735 5G Fate of Acetone in an Outdoor Model Stream with a Nitrate Supplement, Southern Mississippi, U.S.A. W91-10903 5B	W91-10866  BIOINDICATORS  Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers. W91-10469  Microbiological Methods for Safety Testing of Drinking Water Directly Reclaimed from Wastewater. W91-10613  5A  Evaluation of Fecal Enterococci Isolation Media to Indicate Fecal Pollution in Chlorinated Water. W91-10626  Relationship Between Pseudomonas aeruginosa

Protective Effect of Glycine Betaine on Survival of Escherichia coli Cells in Marine Environments.	BIOLOGICAL MAGNIFICATION Phenyltins in Water, Sediment, and Biota of Freshwater Marinas.	Practical Experience with Biological Removal of Phosphorus from Pulp and Paper Mill Ef- fluents.
W91-10637 5B	W91-11342 5B	W91-11496 5D
Effect of Dissolved Nutrients and Inorganic Suspended Solids on the Survival of E. coli in	BIOLOGICAL OXYGEN DEMAND Runoff Characteristics of COD, BOD, C, N, and	Biological Dehalogenation of Kraft Mill Wastewaters.
Seawater. W91-10638 5B	P Loadings from Rivers to Enclosed Coastal Seas.	W91-11497 5D
Miniaturized Fluorogenic Assays for Enumera-	W91-10521 5B	Treatability of Bleached Kraft Pulp and Paper Mill Wastewaters In a New Zealand Aerated
tion of E. coli and Enterococci in Marine Water. W91-10639 5A	Factors Affecting the Relationship Between the NBOD Values and the Amounts of Nitrogenous	Lagoon Treatment System.  W91-11499  5D
Elimination of Coliphages, Clostridium perfrin-	Pollutants: A Field Study on the Lee River. W91-10940 5C	
gens and Human Enteric Viruses During Drink-		BIOLOGICAL WASTEWATER TREATMENT Fate and Effects of Semivolatile Organic Pollut-
ing Water Treatment: Results of Large Volume Samplings.	BIOLOGICAL POLLUTION  Life Cycle Strategies of the Red Tide Causing	ants During Anaerobic Digestion of Sludge.
W91-10654 5F	Flagellates Chattonella (Raphidophyceae) in the	W91-10884 5D
Distinction of Union Calinhams on Hadinatan's	Seto Inland Sea.	Removal of Acetate from NSSC Sulphite Pulp
Difficulty of Using Coliphages as 'Indicators' and 'Index' Organisms.	W91-10546 5B	Mill Condensates Using Thermophilic Bacteria.
W91-10661 5A	BIOLOGICAL STUDIES	W91-10889 5D
Occurrence of Male-Specific and Somatic Bac-	Review of Interbasin Water Transfers with Spe- cific Attention to Biota.	Denitrification by Thermophilic Soil Bacteria
teriophages in Polluted South African Waters.	W91-11013 6B	With Ethanol as Substrate in a USB Reactor.
W91-10662 5B	Removal of Biota from Inter-Basin Transfer	W91-11254 5D
Polyvalent Coliphages in Sewage.	Water.	Effect of a Chelating Agent (DTPA) on Anaero-
W91-10663 5A	W91-11017 5F	bic Wastewater Treatment in an Upflow Sludge
F-Specific RNA Bacteriophages as Model Vi-	Biodegradation of Chemicals at Trace Concen-	Blanket Filter.
ruses in UV Disinfection of Wastewater.	trations.	W91-11277 5D
W91-10682 5D	W91-11102 5B	1-Naphthalenesulfonic acid and Sulfate as Sulfur
Clostridium perfringens, as an Indicator Micro-	Hydrobiological Survey of the Chanomi Creek	Sources for the Green Alga Scenedesmus obli-
organism for the Evaluation of the Effect of	System, Lower Niger Delta, Nigeria.	quus. W91-11326 5D
Wastewater and Sludge Treatment Systems. W91-10686 5D	W91-11524 5C	
	BIOLOGICAL TREATMENT	Application of Physicochemical Treatment to an
Contribution for the Study of New Pathogenic Indicators Removal from W. S. P. in Portugal.	Sewage Sludge Treatment and Use: New Devel- opments, Technological Aspects and Environ-	Overloaded Sewage Works. W91-11357 5D
W91-10689 5D	mental Effects.	
A A Ti-ia Alb-1 Ph 1 Eab	W91-11115 5E	Biodegradation of Benzene and a BTX Mixture Using Immobilized Activated Sludge.
Acute Aquatic Toxicity of Alkyl Phenol Ethox- ylates.	Production, Treatment and Handling of Sewage	W91-11381 5D
W91-10833 5C	Sludge.	Piccolado de Calabia Para de Cara Es
Immunochemical Detection of Cytochrome	W91-11116 5D	Biotechnological Sulphide Removal from Ef- fluents.
P450IA1 Induction in Cod Larvae and Juveniles Exposed to a Water Soluble Fraction of North	Heavy Metal Speciation in Sewage Sludge Fol- lowing a Phyto-Dewatering Treatment.	W91-11502 5D
Sea Crude Oil.	W91-11147 5D	Aerobic and Anaerobic Biofiltration in an Aqua- culture UnitNitrite Accumulation as a Result
W91-10871 5A	Denitrification in Laboratory Sand Columns:	of Nitrification and Denitrification.
Patella vulgata, Mytilus minimus and Hyale pre-	Carbon Regime, Gas Accumulation and Hy-	W91-11547 5D
vosti as Bioindicators for Pb and Se Enrichment in Alexandria Coastal Waters.	draulic Properties. W91-11330 5G	BIOMASS
W91-10875 5A		Microbial Biomass and Biological Activities in
Pactorionhages as Model Visuess in Water Qual-	Biological Bleaching of Wood PulpsA Viable Chlorine-Free Bleaching Technology.	an Acid Sandy Soil Treated with Sewage Sludge
Bacteriophages as Model Viruses in Water Qual- ity Control.	W91-11476 5G	or Farmyard Manure in a Long Term Field
W91-10883 5G	Treatment and Detarification of Assesses	Experiment. W91-11160 5E
Concentration of Metals in Various Larval	Treatment and Detoxification of Aqueous Spruce Bark Extracts by Aspergillus niger.	
Stages of Four Ephemeroptera Species.	W91-11481 5D	BIOREMEDIATION  Comparison Between Model Simulations and
W91-11302 5B	Biodegradability of Chlorinated Organic Com-	Comparison Between Model Simulations and Field Results for In-Situ Biorestoration of Chlor-
Toxicity of Metals to a Freshwater Tubificid Worm, Tubifex tubifex (Muller).		inated Aliphatics: Part 1. Biostimulation of Methanotrophic Bacteria.
W91-11303 5C		W91-10955 5G
Distribution of Fecal Pollution Indicator Bacte-	Onset of Lignin-Modifying Enzymes, Decrease of AOX and Color Removal by White-Rot	BIOTECHNOLOGY
ria in Lake Kinneret.	Fungi Grown on Bleach Plant Effluents.	Strategies for Restoring and Developing Fish
W91-11322 5B	W91-11487 5D	Habitats in the Strait of Georgia: Puget Sound
Gammarus: Asellus Ratio as an Index of Organic	Decrease of Pollutant Level of Bleaching Ef-	Inland Sea, Northeast Pacific Ocean.
Pollution.	fluents and Winning Valuable Products by Suc-	W91-10568 5G
W91-11331 5A	cessive Flocculation and Microbial Growth. W91-11488 5D	Biotechnology Degradation and Mitigation of
Coliphage and Bacteriophage as Indicators of		Offshore Oil Spills, Phase 1. Main Report: Tech- nology to Enhance Biodegradation of Oil Spills
Recreational Water Quality. W91-11334 5A	Membrane Filtration Combined with Biological Treatment for Purification of Bleach Plant Ef-	State of the Art and Perspectives for Technolo-
	fluents.	gy Development.
Downstream Changes in Caddisfly Composition and Abundance in Relation to Changes in Water		W91-10735 5G
Conductivity and Oxygen in the River Butron		Role of Biotechnology in the Treatment of Geo-
Basin.	Deficient Industrial Wastewaters.	thermal Residual Sludges.
W91-11403 50	W91-11494 5D	W91-10744 5D

# BIOTRANSFORMATION

BIOTRANSFORMATION Scavenging Processes of Marine Particles in Osaka Bay.	Anaerobic Treatmen: of Bleached TMP and CTMP Effluent In the BioPAQ UASB System. W91-11501 5D	BRACKISH WATER Introduced Species-Resource or Threat in Brackish-Water Seas: Examples from the Baltic
W91-10538 5B	Organohalogens of Natural and Industrial Origin	and Black Sea. W91-10552 2L
Induction of Biotransformation in the Liver of Eel (Anguilla anguilla L.) by Sublethal Exposure	In Large Recipients of Bleach-Plant Effluents. W91-11505 5B	BRAZIL
to Dinitro-o-cresol: An Ultrastructural and Bio- chemical Study. W91-10826 5C	Formation of Chlorophenols and Related Com- pounds In Natural and Technical Chlorination	Seasonal Variation of Biomass and Production Dynamics for Above and Belowground Compo-
	Processes.	nents of a Spartina alterniflora Marsh in the Euhaline Sector of Paranagua Bay (SE Brazil).
BLACK SEA Present State of Environmental Pollution in	W91-11508 5B Activated Sludge Treatment of Kraft Mill Ef-	W91-10495 2L
Coastal Sea Area and Measures for Protection. W91-10540 5B	fluents from Conventional and Oxygen Bleaching.	Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.
Introduced SpeciesResource or Threat in	W91-11511 5D	W91-10685 5D
Brackish-Water Seas: Examples from the Baltic and Black Sea.	BOHAI BAY	Dams and Sustainable Development in Brazilian
W91-10552 2L	Pollution and Protection of Bohai Bay. W91-10522 5B	Amazonia. W91-11216 8C
BLACK SWAMP	BOILER WATER	Rainwater and Throughfall Chemistry in a
Dendrogeomorphic Approach to Measurement of Sedimentation in a Forested Wetland, Black Swamp, Arkansas.	Investigations With Electrodialysis Reversal for the Treatment of Surface Water to Make-Up	'Terre Firme' Rain Forest: Central Amazonia. W91-11218 2B
W91-11397 2H	Water. W91-11368 5F	BREAKWATERS
BLEACHING		Water Quality Purification System for the En-
Biological Bleaching of Wood Pulps-A Viable Chlorine-Free Bleaching Technology.	BORDEN AQUIFER Geostatistical Characteristics of the Borden Aq-	closed Sea Area. W91-10596 5G
W91-11476 5G	uifer. W91-11234 2F	Deterministic Computer-Aided Optimum
BLEACHING WASTES	BOREHOLE GEOPHYSICS	Deterministic Computer-Aided Optimum Design of Rock Rubble-Mound Breakwater Cross-Sections.
Trends In Water Pollution Control In the Finn- ish Pulp and Paper Industry.	Thermal-Pulse Flowmeter for Measuring Slow Water Velocities in Boreholes.	W91-10785 8A
W91-11468 5G	W91-10766 8G	Rocking Armour Units: Number, Location and
Process Internal Measures to Reduce Pulp Mill Pollution Load.	Hydrogeologic Inferences from Drillers' Logs and from Gravity and Resistivity Surveys in the	Impact Velocity. W91-10786 8A
W91-11473 5G	Amargosa Desert, Southern Nevada.	BRINES
Effects of Chlorination Conditions On the AOX	W91-10996 5E	Brine-Induced Advection of Dissolved Aromat-
and Chlorinated Phenol Content of Kraft Bleach Plant Wastewaters.	Application of Uphole Data from Petroleum Seismic Surveys to Groundwater Investigations,	ic Hydrocarbons to Arctic Bottom Waters. W91-11340 5B
W91-11474 5D	Abu Dhabi (United Arab Emirates). W91-11399 7C	BRITISH COLUMBIA
Biodegradability of Chlorinated Organic Com- pounds In Pulp Bleaching Effluents.	BOREHOLES	Shifts in Fish Vertical Distribution in Response
W91-11484 5D	Thermal-Pulse Flowmeter for Measuring Slow Water Velocities in Boreholes.	to an Internal Seiche in a Stratified Lake. W91-10864 2H
Treatment of Bleaching Effluents In Aerobic/	W91-10766 8G	BUBBLES
Anaerobic Fluidized Biofilm Systems. W91-11486 5D	Analysis and Interpretation of the Borehole	Prospecting for Zones of Contaminated Ground- Water Discharge to Streams Using Bottom-Sedi-
Onset of Lignin-Modifying Enzymes, Decrease	Televiewer Log: Information on the State of Stress and the Lithostratigraphy at Hole 504B.	ment Gas Bubbles.
of AOX and Color Removal by White-Rot Fungi Grown on Bleach Plant Effluents.	W91-11549 7C	W91-10951 5B
W91-11487 5D	BOSTON	BUFFER ZONES
Decrease of Pollutant Level of Bleaching Ef-	Boston's Sewage Outfall. W91-10485 5D	Buffer Strips to Protect Water Supply Reservoirs: A Model and Recommendations.
fluents and Winning Valuable Products by Suc-		W91-10816 5G
cessive Flocculation and Microbial Growth. W91-11488 5D	BOTSWANA Visual Interpretation of a Landsat Mosaic of the	BUOYANCY
Treatment of Bleach-Plant Effluents with Mem-	Okavango Delta and Surrounding Area. W91-10879 2H	Microcystis Changes its Buoyancy in Response to the Average Irradiance in the Surface Mixed
brane Filtration and Sorption Techniques. W91-11489 5D	BOTTOM SEDIMENTS	Layer. W91-10895 2H
	Chemical Composition of the Interstitial Water	W91-10895 2H
Membrane Filtration Combined with Biological Treatment for Purification of Bleach Plant Ef-	in Bottom Sediments of Tyrrhenian Sea (West- ern Mediterranean): Diagenetic Processes.	BUOYANT JETS Surface Dilution of Round Submerged Buoyant
fluents.	W91-10880 2J	Jets.
W91-11490 5D	BOTTOM WATER	W91-10986 5E
Treatment of Pulp-Bleaching Effluents by Acti- vated Sludge, Precipitation, Ozonation and Irra-	Brine-Induced Advection of Dissolved Aromat-	BUTRON RIVER BASIN
diation. W91-11491 5D	ic Hydrocarbons to Arctic Bottom Waters. W91-11340 5B	Downstream Changes in Caddisfly Composition and Abundance in Relation to Changes in Water
	BOUNDARY LAYERS	Conductivity and Oxygen in the River Butron Basin.
Investigation of Anaerobic Removal and Degra- dation of Organic Chlorine from Kraft Bleach-	Rainfall Interception and Boundary Layer Conductance in Relation to Tree Spacing.	W91-11403 5C
ing Wastewaters. W91-11492 5D	W91-10905 2I	CADDISFLIES
Treatability of Bleached Kraft Pulp and Paper Mill Wastewaters In a New Zealand Aerated	BOUNDARY WATERS TREATY Applying Sustainable Development to the Great LakesExperience and Opportunities Under the	Downstream Changes in Caddisfly Composition and Abundance in Relation to Changes in Water Conductivity and Oxygen in the River Butron
Lagoon Treatment System. W91-11499 5D	Boundary Waters Treaty.	Basin. W91-11403 5C
W91-11499 5D	W91-11019 6E	W91-11403 5C

CADMIUM	Delineation of a Discontinuous Aquitard with	Hydrometric Data Collection and Interpretation
Meiofauna of an Experimental Soft Bottom Eco-	Vertical Electrical Soundings, San Bernardino Valley, Southern California.	in the Prairie Provinces and Northwest Territo-
systemEffects of Macrofauna and Cadmium Exposure.	W91-10960 5B	ries. W91-11278 7A
W91-10519 5C	W 91-10900 3B	W91-112/0
	Calibration of a Texture-Based Model of a	CANCER
Ultrastructural and Biochemical Effects of Cad-	Ground-Water Flow System, Western San Joa-	Health Risk Assessment of Water Contaminants
mium on the Aquatic Fern Marsilea minuta	quin Valley, California.	Using Baseline Data of Cancer Incidence in Dif-
Linn.	W91-11101 5B	ferent Water Supply Areas.
W91-10829 5C	C D . W	W91-10614 5F
Distribution of Dissolved Cadmium, Lead and	Crop Data Management Systems, Inc. Meeting California's Pesticide Regulation Challenge.	CANOPY
Copper in the Bristol Channel and the Outer	W91-11177 5G	Rainfall Interception by Trees of Pinus radiata
Severn Estuary.	W91-111//	and Eucalyptus viminalis in a 1300 mm Rainfall
W91-10925 5B	Production Functions Relating Crop Yield,	Area of Southeastern New South Wales: I.
	Water Quality and Quantity, Soil Salintiy and	Gross Losses and Their Variability.
Concentration of Metals in Various Larval	Drainage Volume.	W91-11345 2D
Stages of Four Ephemeroptera Species. W91-11302 5B	W91-11434 3C	
W91-11302		CARBAMATE PESTICIDES
Low Cost Flow Injection Analysis for Cadmium	Geomorphic, Geographic, and Hydrographic	Decreased Norepinephrine and Epinephrine
Using 2-(2-benzothiazolylazo) -4,5-Dimethyl-	Basis for Resolving the Mono Lake Controver-	Contents in Chromaffin Tissue of Rainbow
phenol.	sy.	Trout (Oncorhynchus mykiss) Exposed to
W91-11379 5A	W91-11442 6G	Diethyldithiocarbamate and Amylxanthate.
CAT CAREOUS SOILS	Superfund Record of Decision: Intel (Mountain	W91-10901 5C
CALCAREOUS SOILS	View), CA.	Direct Aqueous Injection-Liquid Chromatogra-
Lead Sorption in Calcareous Soils. W91-11453 5B	W91-11581 5G	phy With Post-Column Derivatization for De-
W91-11433		termination of N-Methylcarbamoyloximes and
CALCITE	CAMPYLOBACTER	N-Methylcarbamates in Finished Drinking
Identity of Suspended Particles in a Calcite-	Study of Campylobacter in Sewage, Sewage	Water: Collaborative Study.
Depositing Stream and Their Significance in	Sludge and in River Water.	W91-11260 5A
Trapping and Binding Phenomena.	W91-10634 5D	
W91-11522 2E		CARBARYL
CATCONING	Latex Agglutination for the Detection of Cam-	Sensitive High-Performance Liquid Chromato-
CALCIUM	pylobacter Species in Water.	graphic Analysis for Toxicological Studies with
History of Cladocera in the Kleiner Barsch-See,	W91-11465 5A	Carbaryl.
an Acidic, Calcium-Poor, Marshy Pond in the Middle European Flatland (Die Geschichte der	CANADA	W91-10920 5A
Cladocerenfauna des Kleinen Barsch-Sees, eines	Analysis of Ground-Probing Radar Data: Pre-	CARBOHYDRATES
Sauren, Kalkarmen Moorweihers im Mitteleuro-	dictive Deconvolution.	
paischen Flachland).	W91-10782 8G	Studies of Dissolved Carbohydrates (or Carbohydrate-Like Substances) in an Estuarine Envi-
W91-11515 2H	W 91-10762 60	ronment.
W91-11313 211	Dioxin Contamination and Growth and Devel-	W91-10840 2L
CALIBRATIONS	opment in Great Blue Heron Embryos.	W91-10840 2L
Levels at Streamflow Gaging Stations.	W91-10837 5C	CARBON CYCLE
W91-11586 7B		Atmospheric Carbon Dioxide and the Global
ALTERANTIC.	Canadian Atlantic Storms Program: Progress	Carbon Cycle: The Key Uncertainties.
CALIFORNIA	and Plans of the Meteorological Component.	W91-11068 5B
Non-Regulatory Approaches to Management of	W91-10943 2B	
Coastal Resources and Development in San	Projection Contains of Normhan Asses off	Influence of Green Plants on the World Carbon
Francisco Bay. W91-10576 2L	Engineering Geology of Nearshore Areas off Richards Island, N.W.T.: A Comparison of	Budget.
W91-103/0	Stable and Actively Eroding Coastlines.	W91-11071 2K
Providing Access for the Public to the Shoreline	W91-10944 2J	Effects of Land Use Alteration on Tropical
of San Francisco Bay.	W 91-10944	Carbon Exchange.
W91-10589 6E	September 5, 1987, Landslide on the La Grande	W91-11072 4C
TV 101 W.1 4	River, James Bay, Quebec, Canada.	W 21-110/2
Health Risk Assessment of Toluene in California	W91-10946 2J	CARBON DIOXIDE
Drinking Water.		Potential Impacts of Climate Change on the
W91-10741 5C	Deep-Seated Consolidation Settlements in the	Great Lakes.
Ground-Water Flow and Solute Movement to	Fraser River Delta.	W91-10480 2H
Drain Laterals, Western San Joaquin Valley,	W91-10948 8D	
California. I. Geochemical Assessment.	Double of Francisco and Antino Commit Water	Some Updated Statistical Assessments of the
W91-10768 5B	Depth of Fractures and Active Ground-Water	Surface Temperature Response to Increased
	Flow in a Clayey Till Plain in Southwestern	Greenhouse Gases.
Pacific Salmon at the Crossroads: Stocks at Risk	Ontario. W91-10959 2F	W91-10969 2E
from California, Oregon, Idaho, and Washing-	W91-10959 2F	Bulation of Atmospheric CO2 to Tannian Sec
ton.	Flood Forecasts on Transboundary Rivers in	Relation of Atmospheric CO2 to Tropical Ser
W91-10834 8I	Hungary with Parallels in Canada.	and Air Temperatures and Precipitation. W91-11002
Effect of Pesticide Treatments on Nontarget Or-	W91-11015 4A	77711002
ganisms in California Rice Paddies.		Great lakes Hydrological Impacts of 2xCO2 Cli-
W91-10835 5C	Interprovincial Water Management in Western	mate Change.
	Canada.	W91-11061 50
Seasonal Influences on the Sediment Transport	W91-11040 6E	
Characteristics of the Sacramento River, Cali-		Environmental Problems and Solutions: Green
fornia.	Will Free Trade Drink Canada Dry.	house Effect, Acid Rain, Pollution.
W91-10847 2J	W91-11041 6D	W91-11066 5H
	Variation of the Stable Instance of Water with	Observational and Theoretical Studies of Green
Zooplankton Effects on Phytoplankton in Lakes	Variation of the Stable Isotopes of Water with	
of Contrasting Trophic Status.	Altitude in the Saint Elias Mountains of Canada. W91-11220 2C	house Climate Effects. W91-11067 50
W91-10859 2H	W91-11220 2C	W91-11067 50
Coefficient of Pollution (p): The Southern Cali-	Knowledge-Based Systems and Operational Hy-	Atmospheric Carbon Dioxide and the Globa
fornia Shelf and Some Ocean Outfalls.	drology.	Carbon Cycle: The Key Uncertainties.
W91-10874 5B	W91-11273 7C	W91-11068 51

# **CARBON DIOXIDE**

Uncertainty in the Projection of Carbon Dioxide	CHANNEL DEGRADATION	Use of 2,2-Dimethoxypropane for the Direct
Emissions.	Channel and Bank Stability of Wolf Creek and a	Gas Chromatographic-Mass Spectrometric De-
W91-11069 5B	Tributary at U.S. Highway 45 Near Wheeler,	termination of Some Organic Compounds in
	Prentiss County, Mississippi.	Water.
Challenge of Sustaining Productivity in the Face	W91-11107 2E	W91-11245 5A
of CO2-Induced Change.	CHANNEL IMPROVEMENT	
W91-11073 5C	CHANNEL IMPROVEMENT  Aquatic Macroinvertebrates of the St. Francis	Preconcentration of Hydrophilic and Hydropho-
	Sunken Lands in Northeast Arkansas.	bic Pesticides from Aqueous Solutions and Ex-
Influence of pH on Phosphate Release from	W91-10844 4C	traction of Residues Using the Polymeric Sor-
Sediments.	W 51-10044	bent Wofatit Y 77.
W91-11327 2H	Fenay Beck Flood-Alleviation Scheme.	W91-11305 5A
1 10 1 Di il	W91-11365 8A	Comparison of Amperometric and UV-Spectro-
Impact of Carbon Dioxide and Ammonium on		photometric Monitoring in the HPLC Analysis
the Growth of Submerged Sphagnum cuspida-	Review of Fisheries Habitat Improvement	of Pesticides.
tum.	Projects in Warmwater Streams, with Recom-	W91-11306 5A
W91-11452 2H	mendations for Wisconsin.	W 71-11500
CARBON MONOXIDE	W91-11591 2H	Multi-Residue-Analysis of Pesticides by HPLC
Ambient Air Co-Modeling in Alaska.	Analysis of Alternative Modifications for Re-	after Solid Phase Extraction.
	ducing Backwater Flooding at the Honey Creek	W91-11307 5A
W91-11070 7C	Coal Strip Mine Reclamation Site in Henry	
CARCINOGENS	County, Missouri.	Application of HPLC Column-Switching in Pes-
Enhancement of Hepatocarcinogenesis in Rain-	W91-11595 2E	ticide Residue Analysis.
bow Trout with Carbon Tetrachloride.		W91-11308 5A
W91-11301 5C	CHANNEL NETWORKS	Analysis of 10 Calcoted Hadisides in West
W 21-11301 3C	Geomorphological Dispersion.	Analysis of 10 Selected Herbicides in Water.
CARP	W91-11232 2E	W91-11311 5A
Models of Seasonal Growth of the Equatorial	CHANNELS	Strategy for Pesticide Control in Ground Water
Carp Labeo dussumieri in Response to the River	Nitrate Removal by Denitrification in Alluvial	and Drinking Water.
Flood Cycle.	Ground Water: Role of a Former Channel.	W91-11312 5A
W91-11559 2H	W91-10909 5B	TA SA
W91-11339 2H	1171-10707	Solid-Phase Extraction for Multi-Residue Analy-
CATCHMENT AREAS	CHARLOTTE HARBOR	sis of Some Triazole and Pyrimidine Pesticides
Maximum Entropy View of Probability-Distrib-	Land Use, Water Use, Streamflow Characteris-	in Water.
uted Catchment Models.	tics, and Water-Quality Characteristics of the	W91-11313 5A
W91-10965 2A	Charlotte Harbor Inflow Area, Florida.	
W71-10703	W91-10771 4C	Simple Spectrophotometric Determination of
CATFISH	CHIPCH DAME	Endosulfan in River Water and Soil.
Occurrence of a South American Armored Cat-	CHECK DAMS	W91-11314 5A
fish in the Hillsborough River, Florida.	Economic Analysis of Off-Farm Soil Conserva-	
W91-10855 2H	tion Structures. W91-11567 4D	Behavior of the Fungicide MBAMT in Water.
W 71-10033	W 91-11307 4D	W91-11315 5A
CATIONS	CHECK STRUCTURES	Low Cost Flow Injection Analysis for Cadmium
Budgets of Selected Cations and Anions in Two	Pressure of Clay Backfill against Retaining	Using 2-(2-benzothiazolylazo) -4,5-Dimethyl-
Forested Experimental Watersheds in Central	Structures.	phenol.
Greece.	W91-10947 8D	W91-11379 5A
W91-11550 4C		W91-11379 3A
1171 11330	CHELATING AGENTS	CHEMICAL COAGULATION
CAVE LAKES	Measurement of the Different Forms of Zinc in	Thermocatalytic and Chemical Treatment of
Use of Electronic Data-Logging Equipment to	Narragansett Bay Water Based on the Rate of	Lignin-Aluminium Sludge and Utilization of the
Monitor Hydrologic Parameters in a Humid	Uptake by a Chelating Resin. W91-10926 2K	Resulting Adsorbent-Coagulant.
Cave Environment in Wind Cave National Park,	W91-10926 2K	W91-11503 5D
South Dakota.	Effect of a Chelating Agent (DTPA) on Anaero-	
W91-11389 7B	bic Wastewater Treatment in an Upflow Sludge	CHEMICAL COMPOSITION
	Blanket Filter.	Chemical Composition of Late- and Post-Glacial
CAVES	W91-11277 5D	Sediments (Fe, Mn, P, C, N, N, H and BSi) in
Use of Electronic Data-Logging Equipment to		Lake Kleiner Barsch-See, a Bog Lake in the
Monitor Hydrologic Parameters in a Humid	CHEMICAL ANALYSIS	North of GDR (Die Chemische Zusammenset-
Cave Environment in Wind Cave National Park,	Surveillance Solutions to Microbiological Prob-	zung der Spat- und Postglazialsedimente des
South Dakota.	lems in Water Quality Control in Developing	Kleinen Barsch-Sees (Fe, Mn, P, C, N, H und
W91-11389 7B	Countries.	BSi), eines Dystrophen Moorweihers im Norden
	W91-10625 5G	der DDR).
CAYMAN ISLANDS	Determination of Subnanomolar Levels of	W91-11518 2H
Waste Stabilization Ponds in Grand Cayman,	Iron(II) and Total Dissolved Iron in Seawater	Influence of Pleaded C-2 - Charles C
Cayman Islands.	by Flow Injection Analysis with Chemilumines-	Influence of Flooded Soil on Chemical Compo-
W91-10691 5D	cence Detection.	sition of Annual Ryegrass and Digestibility by
	W91-10773 2K	Meadow Voles.
CENTRIFUGATION	- LR	W91-11536 2I
Use of a Single-Bowl Continuous-Flow Centri-	Spectrophotometric Determination of Nitrite in	CHEMICAL OXYGEN DEMAND
fuge for Dewatering Suspended Sediments:	Polluted Waters Using 3-Nitroaniline.	Runoff Characteristics of COD, BOD, C, N, and
Effect on Sediment Physical and Chemical	W91-10823 5A	P Loadings from Rivers to Enclosed Coastal
Characteristics.	Simultaneous Ultraviolet Spectrophotometric	Seas.
W91-11350 7B		
		W91-10321
	Determination of Nitrate and Nitrite in Water.	W91-10521 5B
CESIUM		CHEMICAL PRECIPITATION
Dynamic Model of Caesium Transport in Lakes	Determination of Nitrate and Nitrite in Water.	
Dynamic Model of Caesium Transport in Lakes and Their Catchments.	Determination of Nitrate and Nitrite in Water. W91-10824 5A  Rapid Preconcentration Method for Multiele-	CHEMICAL PRECIPITATION
Dynamic Model of Caesium Transport in Lakes	Determination of Nitrate and Nitrite in Water. W91-10824 5A Rapid Preconcentration Method for Multielement Analysis of Natural Freshwaters.	CHEMICAL PRECIPITATION Treatment of Pulp-Bleaching Effluents by Acti-
Dynamic Model of Caesium Transport in Lakes and Their Catchments. W91-10934 5B	Determination of Nitrate and Nitrite in Water. W91-10824 5A  Rapid Preconcentration Method for Multielement Analysis of Natural Freshwaters. W91-10892 7B	CHEMICAL PRECIPITATION  Treatment of Pulp-Bleaching Effluents by Activated Sludge, Precipitation, Ozonation and Irra-
Dynamic Model of Caesium Transport in Lakes and Their Catchments. W91-10934 5B CESIUM RADIOISOTOPES	Determination of Nitrate and Nitrite in Water. W91-10824 5A Rapid Preconcentration Method for Multielement Analysis of Natural Freshwaters. W91-10892 7B Chromatographic Separation of Arsenic Species	CHEMICAL PRECIPITATION  Treatment of Pulp-Bleaching Effluents by Activated Sludge, Precipitation, Ozonation and Irradiation.  W91-11491  5D
Dynamic Model of Caesium Transport in Lakes and Their Catchments.  W91-10934 5B  CESIUM RADIOISOTOPES  Dynamic Model of Caesium Transport in Lakes	Determination of Nitrate and Nitrite in Water. W91-10824 5A  Rapid Preconcentration Method for Multielement Analysis of Natural Freshwaters. W91-10892 7B  Chromatographic Separation of Arsenic Species with Sodium Bis(trifluoroethyl)dithiocarbamate	CHEMICAL PRECIPITATION  Treatment of Pulp-Bleaching Effluents by Activated Sludge, Precipitation, Ozonation and Irradiation.  W91-11491  5D  Pre-hydrolyzed Aluminum Hydroxide and Iron
Dynamic Model of Caesium Transport in Lakes and Their Catchments. W91-10934 5B CESIUM RADIOISOTOPES	Determination of Nitrate and Nitrite in Water. W91-10824 5A Rapid Preconcentration Method for Multielement Analysis of Natural Freshwaters. W91-10892 7B Chromatographic Separation of Arsenic Species	CHEMICAL PRECIPITATION  Treatment of Pulp-Bleaching Effluents by Activated Sludge, Precipitation, Ozonation and Irradiation.  W91-11491  5D

CHEMICAL PROPERTIES  Causes of Degradation of Chemical and Physical Properties of Chernozems Irrigated with Non- mineralized Water.	CHESAPEAKE BAY Iodine Chemistry in the Water Column of the Chesapeake Bay: Evidence for Organic Iodine	Behavior of Chlorobenzenes in Ise Bay, Estimated from Their Concentrations in Various Environmental Media.
W91-10913 2G	Forms. W91-10496 2L	W91-11325 5B
Algicidal and Chemical Effect of u.vRadiation of Water Containing Humic Substances.	Environmental Research, Policy and Regula- tion: The Chesapeake Bay Experience.	Organohalogens of Natural and Industrial Origin In Large Recipients of Bleach-Plant Effluents. W91-11505 5B
W91-10941 5F	W91-10575 5G	
CHEMICAL RECOVERY Synthesis and Decomposition of Novel Organo- phosphorus Complexants. W91-11372 5D	Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA.	Anaerobic Degradation of PCP and Phenol In Fixed-Film Reactors: The Influence of an Addi- tional Substrate. W91-11512 5D
	W91-10610 2L	CHI ORDIVED INIDROGERDON
CHEMICAL SPECIATION  Multicomponent Kinetic Analysis of Iron Speciation in Humic Lake Tjeukemeer: Comparison	Critical Area Program of Maryland: Is it Cleaning Up the Chesapeake Bay.	CHLORINATED HYDROCARBON INSECTICIDES Transformation of (C-14)-2,4-Dichlorophenol in
of Fulvic Acid from the Drainage Basin and	W91-11006 6B	Saskatchewan Soils. W91-10922 5B
Lake Water Samples. W91-11339 2H	Interstate Cooperation in Dealing with Growth Related Water Quality Impacts on the Chesa- peake Bay.	W91-10922 5B CHLORINATED HYDROCARBONS
CHEMICAL TRACERS  Characteristics of Rhodamine WT and Fluores-	W91-11009 6E	Determination of Chlorinated Phenoxy Acid and Ester Herbicides in Soil and Water by
cein as Adsorbing Ground-Water Tracers. W91-10952 5B	CHESTNUT SOILS  Effect of Long-Term Application of Fertilizers	Liquid Chromatography Particle Beam Mass Spectrometry and Ultraviolet Absorption Spec-
CHEMICAL TREATMENT	on the Agrophysical Properties of an Irrigated	trophotometry.
Sludge Reduction Possibilities as Demonstrated	Light-Chestnut Soil.	W91-10893 5A
by the Chemolysis Process Dow Stade GmbH.	W91-10914 2G	Enhancement of Hepatocarcinogenesis in Rain-
W91-11118 5D	CHICOT AQUIFER	bow Trout with Carbon Tetrachloride.
Chemolysis Process of Dow Stade GMBH. W91-11144 5D	Geohydrology and Simulation of Flow in the Chicot Aquifer System of Southwestern Louisi-	W91-11301 5C Bioconcentration of Chlorinated Aromatic Hy-
Conductivity for Nutrient Control In CTMP	ana. W91-11100 2F	drocarbons in Aquatic Macrophytes.
Wastewater Treatment. W91-11495 5D	CHINA	W91-11338 5B
Anaerobic Treatment of Bleached TMP and	Pollution and Protection of Bohai Bay. W91-10522 5B	Electrolytic Model System for Reductive Deha- logenation in Aqueous Environments.
CTMP Effluent In the BioPAQ UASB System. W91-11501 5D	Studies on the Situation of Pollution and Coun-	W91-11343 5B
W91-11501 5D CHEMISTRY OF PRECIPITATION	termeasures of Control of the Oceanic Environ- ment in Zhoushan Fishing Ground: The Largest	Stimulation of the Reductive Dechlorination of Tetrachloroethene in Anaerobic Aquifer Micro-
Increased Precipitation Acidity in the Central Sierra Nevada.	Fishing Ground in China. W91-10559 5C	cosms by the Addition of Toluene. W91-11344 5B
W91-10471 5B		
Analysis of Precipitation Chemistry Measure- ments in Shimane, Japan.	Toward Environmental Planning for East Asian Estuaries: Japanese and Chinese Enclosed Bays.	Trends in Pollution Control In the Swedish Pulp and Paper Industry.
W91-10472 2B	W91-10565 2L	W91-11469 5G
Impact of Changing Regional Emissions on Pre- cipitation Chemistry in the Eastern United	Environmental Assessment of Wastewater Marine Disposal of Xiaogang Zone, Ningbo. W91-10570 5E	Effects of Chlorination Conditions On the AOX and Chlorinated Phenol Content of Kraft Bleach Plant Wastewaters.
States. W91-10473 5G	Runoff Analysis of the Chang Jiang (The	W91-11474 5D
Relationship Between Mean and Standard Devi-	Yangtze River). W91-10966 2E	Identification of Dioxin Sources In an Integrated Wood Processing Facility.
ation in Precipitation Chemistry Measurements Across Eastern North America.	Variation of Moisture Conditions in China	W91-11475 5B
W91-10475 2B	during the Last 2000 Years. W91-10971 2A	Biodegradability of Chlorinated Organic Com-
Chemical Composition of Individual Storms as a Function of Air Parcel Trajectories for the Pre-	Environmental Isotope Study for Estimating	pounds In Pulp Bleaching Effluents. W91-11484 5D
diction of Acid Rain Characteristics. W91-11075 5B	Leakage and Runoff of Ground Waters in the Xi'an Area.	Investigation of Anaerobic Removal and Degra-
Rainwater and Throughfall Chemistry in a	W91-10994 2F	dation of Organic Chlorine from Kraft Bleach- ing Wastewaters.
'Terre Firme' Rain Forest: Central Amazonia. W91-11218 2B	CHLORIDES Modelling Water and Solute Transport in Ma-	W91-11492 5D
Sequential Sampling of Particles, Major Ions and Total Trace Metals in Wet Deposition.	croporous Soil. II. Chloride Breakthrough Under Non-Steady Flow.	Biological Dehalogenation of Kraft Mill Wastewaters. W91-11497 5D
W91-11249 5B	W91-10804 2G	
Major Ions in Marine Rainwater With Attention to Sources of Alkaline and Acidic Species. W91-11250 5B	Effect of Land Development on Groundwater Recharge Determined from Non-Steady Chlo- ride Profiles. W91-10991 4C	Factors Affecting the Removal and Discharge of Organic Chlorine Compounds at Activated Sludge Treatment Plants. W91-11498 5D
Aerosol and Hydrometeor Concentrations and		Treatment Technologies for Organochlorine-
Their Chemical Composition During Winter Precipitation Along a Mountain Slope: III. Size- Differentiated In-Cloud Scavenging Efficiencies: W91-11253	Selective Concentration of Lead(II) Chloride Complex With Liquid Anion-Exchange Mem- branes. W91-11247 5D	Containing Sludges and Concentrates from Ex- ternal Treatment of Pulp and Paper Wastewaters.
CHERNOBYL	CHLORINATED AROMATIC COMPOUNDS	W91-11500 5D
Evidence of Chernobyl Fallout on a Temperate Himalayan Glacier. W91-10950 5B	Distribution of Chlorobenzenes in the Bottom Sediments of Ise Bay.	Organohalogens of Natural and Industrial Origin In Large Recipients of Bleach-Plant Effluents. W91-11505 5B

# SUBJECT INDEX

# CHLORINATED HYDROCARBONS

Distribution of Halogenated Organic Com- pounds (AOX)Swedish Transport to Surround- ing Sea Areas and Mass Balance Studies In Five	CHROMIUM  Heavy Metal Distribution in the Godvari River Basin.	CLEANUP OPERATIONS Long Climb to Remediation.
Drainage Systems.	W91-11445 5B	W91-10483 5G
W91-11506 5B	CLARIFIERS	Superfund Record of Decision: Commencement Bay/S. Tacoma, WA.
Monitoring of Organochlorine Compounds In	Rectangular Clarifiers Should Be Considered.	W91-10711 5G
Finnish Inland Waters Polluted by Pulp and Paper Effluents Using the Mussel Incubation	W91-11223 5D	Superfund Record of Decision: Chemtronics
Method.	Case for Circular Clarifiers.	(Amendment), NC.
W91-11507 5A	W91-11224 5D	W91-10713 5G
Formation of Chlorophenols and Related Com-	CLASSIFICATION	Superfund Record of Decision: IBM (San Jose),
pounds In Natural and Technical Chlorination	Classification of Snow Cover and Precipitation	CA.
Processes. W91-11508 5B	Using the Special Sensor Microwave Imager. W91-11219 7B	W91-10715 5G
Activated Sludge Treatment of Kraft Mill Ef-	CLAY SOILS	Using Oil Spill Dispersants on the Sea.
fluents from Conventional and Oxygen Bleach-	Depth of Fractures and Active Ground-Water	W91-10716 5G
ing. W91-11511 5D	Flow in a Clayey Till Plain in Southwestern	Superfund Record of Decision: Delaware Sand
W91-11311	Ontario. W91-10959 2F	and Gravel, DE. W91-10717 5G
CHLORINATION		W91-10717 5G
Evaluation of Fecal Enterococci Isolation Media to Indicate Fecal Pollution in Chlorinated	CLAYS	Superfund Record of Decision: Pesses Chemical,
Water.	Change in Pore Size Distribution Owing to Sec- ondary Consolidation of Clays.	TX. W91-10718 5G
W91-10626 5F	W91-10774 8D	W91-10/18
Effectivity of Chlorine Dioxide to Control Aer-	Finite-Element Analysis of Softening Effects in	Superfund Record of Decision: Iron Horse Park,
omonas in Drinking Water Distribution Systems.	Fissured, Overconsolidated Clays and Mud-	MA. W91-10719 5G
W91-10677 5F	stones.	W 91-10/19
Chlorine Resistance of Motile Aeromonas spp.	W91-10776 8D	Superfund Record of Decision: South Valley
W91-10678 5F	Electroosmotic Strengthening of Soft Sensitive	(PL-83), NM. W91-10721 5G
Salmonella Detection in Sewage Waters Using	Clays.	
Fluorescent Antibodies.	W91-10777 8D	Superfund Record of Decision: Reich Farms,
W91-10687 5D	Field Test of Electroosmotic Strengthening of	NJ. W91-10743 5G
Effects of Chlorination Conditions On the AOX	Soft Sensitive Clay. W91-10778 8D	
and Chlorinated Phenol Content of Kraft Bleach Plant Wastewaters.	W91-10778 8D	Superfund Record of Decision. Mid-State Dis-
W91-11474 5D	Analysis of a Sanitary-Embankment Failure	posal Landfill, WI. W91-10749 5G
Formation of Chlorophenols and Related Com-	Over the Rio de Janeiro Soft Clay Deposit. W91-10780 8D	
pounds In Natural and Technical Chlorination		Superfund Record of Decision: Kin-Buc Land- fill, NJ.
Processes.	CLEAN AIR ACT	W91-10755 5G
W91-11508 5B	Ambient Air Co-Modeling in Alaska. W91-11070 7C	Soundard Board of Desiries Bulgarder 71-
CHLORINE		Superfund Record of Decision: Palmerton Zinc Pile, PA.
Chlorine Resistance of Motile Aeromonas spp. W91-10678	CLEAN WATER ACT Nonpoint Sources: Agenda for the Future.	W91-10756 5G
	W91-11098 6E	Superfund Record of Decision: Celanese Fibers
Activity of Peracetic Acid on Sewage Indicator	Future Directions for Water Resources.	Operations, NC.
Bacteria and Viruses. W91-10683 5D	W91-11208 4A	W91-10759 5G
		Mechanistic Evaluation of Mitigation of Petrole-
Effectivity of Chlorine Dioxide to Control Aer-	CLEANUP Aquifer Restoration: Which Method.	um Hydrocarbon Contamination by Soil
omonas in Drinking Water Distribution Systems.	W91-10486 5G	Medium.
W91-10677 5F	Use of Respiration in the Sandy Beach or on the	W91-10779 5G
CHLORNITROFEN	Tidal Flat: 1. Permeable Sandy Beach.	Analytical Modeling of Aquifer Decontamina-
Effects of Chlornitrofen, a Herbicide, on Repro-	W91-10541 5G	tion by Pumping When Transport is Affected by Rate-Limited Sorption.
duction of Brachionus urceolaris (Rotatoria) Through Water and Food (Chlorella).	Treatability of Hazardous Chemicals in Soils:	W91-11235 5G
W91-11458 5C	Volatile and Semivolatile Organics.	
CHLOROPHYLL	W91-10712 5B	Optimal Data Acquisition Strategy for the De- velopment of a Transport Model for Ground-
Comparison of Nutritional Environment of	Biotechnology Degradation and Mitigation of	water Remediation.
Closed Coastal Seas in Western Kyushu.	Offshore Oil Spills, Phase 1. Main Report: Tech-	W91-11238 5G
W91-10595 2L	nology to Enhance Biodegradation of Oil Spills State of the Art and Perspectives for Technolo-	Removal of Heavy Metals and Other Cations
Relationship of MSS and TM Digital Data with	gy Development.	From Wastewater Using Zeolites.
Suspended Sediments, Chlorophyll, and Tem- perature in Moon Lake, Mississippi.	W91-10735 5G	W91-11369 5D
W91-11354 7C	Aqueous Surfactant Washing of Residual Oil	Application of Supported Liquid Membranes for
	Contamination from Sandy Soil.	Removal of Uranium From Groundwater.
Transport of the Fungicide Chlorothalonil from	W91-10796 5G	W91-11370 5G
Its Operational Use on a Pond Ecosystem.	Development and Implementation of a Remedial	Remediation of Floating, Open Water Oil Spills:
W91-11299 5B	Investigation Work Plan and Data Management	Comparative Efficacy of Commercially Avail-
CHROMATOGRAPHY	System. W91-10799 5G	able Polypropylene Sorbent Booms. W91-11447 5G
Chromatographic Separation of Arsenic Species		
with Sodium Bis(trifluoroethyl)dithiocarbamate Chelation.	Soil Clean Up by In-situ Aeration: VI. Effects of Variable Permeabilities.	Superfund Record of Decision: Intel (Mountain View), CA.
W91-10894 5A	W91-11317 5G	W91-11581 5G

Superfund Record of Decision: Whitmoyer Lab-	Challenge of Sustaining Productivity in the Face	Spring and Summer 1988 Drought over the
oratories, PA.	of CO2-Induced Change.	Contiguous United States-Causes and Predic-
W91-11582 5G	W91-11073 5C	tion. W91-11412 2B
Assessment of International Technologies for Superfund Applications.	Approaches to the Simulation of Regional Climate Change: A Review.	Spatial Distribution of Precipitation Seasonality
W91-11584 5G	W91-11427 5C	in the United States.
CLEARCUTTING	CIDALTICIDATA	W91-11414 2B
Budgets of Selected Cations and Anions in Two	CLIMATIC DATA	Satellite-Derived Integrated Water-Vapor Dis-
Forested Experimental Watersheds in Central	Tree-Ring Reconstructed Sunshine Duration over Central USA.	tribution in Oceanic Midlatitude Storms: Varia-
Greece.	W91-10972 2I	tion with Region and Season.
W91-11550 4C	W71-107/2	W91-11419 2B
CLIMATE CHANGE	Soil Moisture: Empirical Data and Model Re-	
Great lakes Hydrological Impacts of 2xCO2 Cli-	sults.	Approaches to the Simulation of Regional Cli-
mate Change.	W91-11413 2G	mate Change: A Review.
W91-11061 5C	Multispectral Satellite Data in the Context of	W91-11427 5C
CLIMATE CHANGES	Land Surface Heat Balance.	Multispectral Satellite Data in the Context of
Potential Impacts of Climate Change on the	W91-11428 7B	Land Surface Heat Balance.
Great Lakes.		W91-11428 7B
W91-10480 2H	CLIMATOLOGY	
	ESCCP Cloud Data Products.	CLOSED BASINS
CLIMATE EFFECTS	W91-10479 2B	Ground-Water Control of Evaporite Deposition.
Interpretation of Hydrologic Effects of Climate Change in the Sacramento-San Joaquin River	Zonal Average Cloud Characteristics for Global	W91-11438 2K
Basin, California.	Atmospheric Chemistry Modelling.	CLOSED LAKES
W91-11552 5C	W91-10728 2B	Geomorphic, Geographic, and Hydrographic
		Basis for Resolving the Mono Lake Controver-
CLIMATES	Potential Effects of Global Warming on the	sy.
Meteorology and Oceanography in the Seto Inland Sea.	Primary Productivity of a Subalpine Lake.	W91-11442 6G
W91-10520 2L	W91-10819 2H	CLOSTRIDIUM
W)1-10320	Microclimatological Investigations in the Tropi-	Elimination of Coliphages, Clostridium perfrin-
Multispectral Satellite Data in the Context of	cal Alpine Scrub of Maui, Hawaii: Evidence for	gens and Human Enteric Viruses During Drink-
Land Surface Heat Balance.	a Drought-Induced Alpine Timberline.	ing Water Treatment: Results of Large Volume
W91-11428 7B	W91-10878 2I	Samplings.
CLIMATIC CHANGES	0 T. L. 1 C. dd 1 A 6 d	W91-10654 5F
Research on Clouds and Precipitation: Past,	Some Updated Statistical Assessments of the Surface Temperature Response to Increased	on
Present and Future, Part II.	Greenhouse Gases.	Clostridium perfringens, as an Indicator Micro-
W91-10481 3B	W91-10969 2B	organism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems.
Geochemical Evidence Supporting T. C. Cham-		W91-10686 5D
berlin's Theory of Glaciation.	Climatic Change and Future Agroclimatic Po-	W 71-10000
W91-10790 2C	tential in Europe.	CLOUD CHEMISTRY
	W91-10970 2B	Modelling the Atmospheric Transport of Trace
Organic Carbon Accumulation in Baffin Bay	Variation of Moisture Conditions in China	Metals Including the Role of Precipitating
and Paleoenvironment in High Northern Lati- tudes During the Past 20 m. y.	during the Last 2000 Years.	Clouds.
W91-10791 2J	W91-10971 2A	W91-11251 5B
		Aerosol and Hydrometeor Concentrations and
Potential Effects of Global Warming on the	Tree-Ring Reconstructed Sunshine Duration	Their Chemical Composition During Winter
Primary Productivity of a Subalpine Lake. W91-10819 2H	over Central USA. W91-10972 2I	Precipitation Along a Mountain Slope: III. Size-
W91-10819 2H	W91-109/2	Differentiated In-Cloud Scavenging Efficiencies.
Effects of Climate Change on Discharges and	Relation of Atmospheric CO2 to Tropical Sea	W91-11253 2B
Snow Cover in Finland.	and Air Temperatures and Precipitation.	CLOUD COVER
W91-10964 2C	W91-11002 2B	ESCCP Cloud Data Products.
Some Updated Statistical Assessments of the	Water Supply Implication of Climate Change in	W91-10479 2B
Surface Temperature Response to Increased	Water Supply Implication of Climate Change in Western North American Basins.	
Greenhouse Gases.	W91-11059 2B	Cloud/Cryosphere Interactions.
W91-10969 2B		W91-11095 2B
Climatic Character & Character Ba	Observational and Theoretical Studies of Green-	CLOUD PHYSICS
Climatic Change and Future Agroclimatic Po- tential in Europe.	house Climate Effects.	Cloud/Cryosphere Interactions.
W91-10970 2B	W91-11067 5C	W91-11095 2B
	Challenge of Sustaining Productivity in the Face	
Variation of Moisture Conditions in China	of CO2-Induced Change.	Modelling the Atmospheric Transport of Trace
during the Last 2000 Years. W91-10971 2A	W91-11073 5C	Metals Including the Role of Precipitating
W91-10971 2A	The state of the s	Clouds. W91-11251 5B
Relation of Atmospheric CO2 to Tropical Sea	Variation of the Stable Isotopes of Water with	W71-11231 3B
and Air Temperatures and Precipitation.	Altitude in the Saint Elias Mountains of Canada. W91-11220 2C	Efficiency With Which Drizzle and Precipita-
W91-11002 2B	W 51-11220	tion Sized Drops Collide With Aerosol Particles.
Water Supply Implication of Climate Change in	Simulation of Precipitation by Weather Type	W91-11252 2B
Western North American Basins.	Analysis.	Effect of Decoupled Low-Level Flow on
W91-11059 2B	W91-11230 2B	Effect of Decoupled Low-Level Flow on Winter Orographic Clouds and Precipitation in
	Variability of Glacier Mass Balances in Western	the Yampa River Valley.
Simulated Hydrologic Effects of Climatic	North America.	W91-11410 2B
Change in the Delaware River Basin. W91-11060 5C	W91-11391 2C	
W91-11060 5C		CLOUD SEEDING
Observational and Theoretical Studies of Green-	Persistent Patterns of Thunderstorm Activity in	Research on Clouds and Precipitation: Past,
house Climate Effects.	the Central United States.	Present and Future, Part II. W91-10481 3B
W91-11067 5C	W91-11411 2B	W 71-10401 3D

# CLOUDS

CLOUDS	Engineering Geology of Nearshore Areas off	International Programme for the Protection of a
Research on Clouds and Precipitation: Past,	Richards Island, N.W.T.: A Comparison of	Semi-Enclosed Sea: The Mediterranean Action
Present and Future, Part II.	Stable and Actively Eroding Coastlines.	Plan.
W91-10481 3B	W91-10944 2J	W91-10574 5G
Zonal Average Cloud Characteristics for Global	COASTAL WATERS	Environmental Research, Policy and Regula-
Atmospheric Chemistry Modelling.	Pollution and Protection of Bohai Bay.	tion: The Chesapeake Bay Experience.
W91-10728 2B	W91-10522 5B	W91-10575 5G
Kinematic, Dynamic, and Thermodynamic	Evaluation of Primary Production Loads and	Controlling Effect of the Planned Management
Analysis of a Weakly Sheared Severe Thunder-	Their Control in Enclosed Seas.	of the Environment in the Kagoshima Bay on
storm over Northern Alabama.	W91-10524 5G	the Pollutant Load.
W91-11417 2B	Water Exchange and Transport of Matter in the	W91-10579 5G
COAL MINING	Seto Inland Sea.	Environmental Information Processing of
Description of the Physical Environment and	W91-10527 2L	Closed Bay Area by Remote Sensing.
Coal-Mining History of West-Central Indiana,	f V - C i - i C P i P C - M -	W91-10581 7B
with Emphasis on Six Small Watersheds.	5-Year Scientific Research Programme for Managing Coastal Seas.	n
W91-11576 2E	W91-10531 2L	Eutrophication Mechanisms of Coastal Seas in Yamaguchi Prefecture.
Analysis of Alternative Modifications for Re-		W91-10593 5B
ducing Backwater Flooding at the Honey Creek	Investigation on Turbidity and Flow Patterns in	
Coal Strip Mine Reclamation Site in Henry	Half-Closed Sea Area. W91-10532 5B	Comparison of Nutritional Environment of
County, Missouri. W91-11595 2E	***************************************	Closed Coastal Seas in Western Kyushu. W91-10595 2L
W91-11595 2E	Change of Oceanic Condition by the Man-Made	W91-10595 2L
COAL MINING EFFECTS	Structure for Upwelling.	Sediment Transport on the Foreshore.
Coal Mine Waters and Their Influence on the	W91-10542 8I	W91-10599 2L
Purity Ecological State of River and the Fish Production.	Life Cycle Strategies of the Red Tide Causing	East Asian Seas: Hypothetical Oil Spill Trajec-
W91-10605 5B	Flagellates Chattonella (Raphidophyceae) in the	tories.
W 91-10003	Seto Inland Sea.	W91-10608 5B
COASTAL AREAS	W91-10546 5B	
Water Quality Management Issues in Lingayen	Changes and Stress Signs in Plankton Communi-	Improved Policy Instruments for Management
Gulf, Philippines and Some Proposed Solutions.	ties as a Result of Man-Induced Perturbations in	of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA.
W91-10523 5G	Enclosed Coastal Seas (Mediterranean, Baltic).	W91-10610 2L
Present State of Environmental Pollution in	W91-10547 5C	
Coastal Sea Area and Measures for Protection.	Growth Potentials of Red Tide Phytoplankters	Enumeration of Motile Aeromonas in Valencia
W91-10540 5B	in Coastal Seawater by AGP Assay.	Coastal Waters by Membrane Filtration.
Long Term Ecological Changes in the Gulf of	W91-10548 5A	W91-10636 5B
Thailand.	Studies on the Situation of Pollution and Coun-	Effect of Three Primary Treatment Sewage
W91-10551 5B	termeasures of Control of the Oceanic Environ-	Outfalls on Metal Concentrations in the Fish
Introduced Species-Resource or Threat in	ment in Zhoushan Fishing Ground: The Largest	Cheilodactylus fuscus Collected Along the
Brackish-Water Seas: Examples from the Baltic	Fishing Ground in China. W91-10559 5C	Coast of Sydney, Australia. W91-10873 5B
and Black Sea.	W 91-10339	W 21-100/3
W91-10552 2L	Incidence and Ecology of Marine Fouling Orga-	Volatile Organic Compounds in Two Polluted
Eastern Mediterranean: A Marine Desert.	nisms in the Eastern Harbour of Alexandria,	Rivers in Barcelona (Catalonia, Spain).
W91-10553 2H	Egypt. W91-10560 5C	W91-10887 5B
P. 41 P. 16	W71-10300	Rotifers of the Genus SynchaetaAn Important
Benthic Faunal Succession in a Cove Organical- ly Polluted by Fish Farming.	Egyptian Approach Towards Appropriate Use	Component of the Zooplankton in the Coastal
W91-10554 5C	of Coastal Zones on the Red Sea. W91-10561 6G	Waters of the Southern Baltic.
	W91-10361 60	W91-11519 2L
Management of the Marine Environment in	Impact of Coastal Development on the Infralit-	COASTAL ZONE DEVELOPMENT
Western Australia: An Ecosystem Approach. W91-10583 5G	toral Zone Along the Southeastern Mediterrane-	Impact of Coastal Development on the Infralit-
W 71-10363	an Shore of Continental France. W91-10562 6G	toral Zone Along the Southeastern Mediterrane-
Providing Access for the Public to the Shoreline		an Shore of Continental France. W91-10562 6G
of San Francisco Bay.	Kansai International Airport Project and Envi-	W91-10562 6G
W91-10589 6E	ronmental Impact Assessment.	COASTAL ZONE MANAGEMENT
Regional-Wide Waste Disposal Project on Sea-	W91-10563 4C	Managing Oregon's Estuarine Resources Lands.
coast of Enclosed Coastal Sea.	Modern Environmental Assessment Procedures	W91-10508 2L
W91-10594 5E	for Enclosed Seas.	Seagrass-Mangrove Ecosystems Management: A
COASTAL ENGINEERING	W91-10564 6G	Key to Marine Coastal Conservation in the
Rocking Armour Units: Number, Location and	Study on Model Reference Adaptive Water Pol-	ASEAN Region.
Impact Velocity.	lution Control in Enclosed Coastal Sea.	W91-10539 5G
W91-10786 8A	W91-10567 5G	Summary of Ports and Marine Environment Im-
COASTAL ENVIRONMENT	Strategies for Restoring and Developing Fish	provement Work and Example of Latest Meas-
Effect of Coastal Sea Level Forcing on Indian	Habitats in the Strait of Georgia: Puget Sound	ures in Seto Inland Sea.
River Bay and Rehoboth Bay, Delaware.	Inland Sea, Northeast Pacific Ocean.	W91-10545 5G
W91-10494 2L	W91-10568 5G	Egyptian Approach Towards Appropriate Use
Seagrass-Mangrove Ecosystems Management: A	Assessment of the Environmental Capacity of	of Coastal Zones on the Red Sea.
Key to Marine Coastal Conservation in the	Enclosed Coastal Sea.	W91-10561 6G
ASEAN Region.	W91-10571 5E	
W91-10539 5G	Countermeasures Against Water Pollution in	Impact of Coastal Development on the Infralit- toral Zone Along the Southeastern Mediterrane-
Wetland Impoundments of East-Central Florida.	Enclosed Coastal Seas in Japan.	an Shore of Continental France.
W91-10854 2L	W91-10572 5G	W91-10562 6G

Kansai International Airport Project and Envi-	COEFFICIENT OF POLLUTION	COMPETING USE
ronmental Impact Assessment.	Coefficient of Pollution (p): The Southern Cali-	Photographs Written Historical and Descriptive
W91-10563 4C	fornia Shelf and Some Ocean Outfalls.	Data.
Toward Environmental Planning for East Asian	W91-10874 5B	W91-11577 6E
Estuaries: Japanese and Chinese Enclosed Bays.	COLD REGIONS	
W91-10565 2L	Bioavailability of Organic Pollutants in Boreal	COMPOST MARKETING
	Waters with Varying Levels of Dissolved Or-	Existing Conditions for Agricultural Utilization
Ecological Assessment of Semi-Enclosed Marine	ganic Material.	of Sewage Sludge Compost in Japan.
Water Bodies of the Archipelago Sabana-Cama-	W91-10936 5B	W91-11152 5E
guey (Cuba) Prior to Tourism Development		COMPOSTING
Projects. W91-10566 6G	COLIFORMS	Control of Enteric Micro-organisms by Aerobic-
W 91-10300 0G	Coliform Bacteria in Drinking Water from	Thermophilic Co-Composting of Wastewater
Non-Regulatory Approaches to Management of	South Bavaria: Identification by the API 20E-	Sludge and Agro-Industry Sludge.
Coastal Resources and Development in San	System and Resistance Patterns. W91-10627 5F	W91-10693 5E
Francisco Bay.	W91-1002/	
W91-10576 2L	COLIPHAGES	Modifications of Some Physical Properties in
Controlling Effect of the Planned Management	Difficulty of Using Coliphages as 'Indicators'	Two Compost-Amended Italian Soils.
of the Environment in the Kagoshima Bay on	and 'Index' Organisms.	W91-11148 5E
the Pollutant Load.	W91-10661 5A	Composting Raw Sewage Sludge in the Absence
W91-10579 5G	Belovelent Celishages in Savese	of Bulking Agents.
Personal Commutes Senten Sententine Water	Polyvalent Coliphages in Sewage. W91-10663 5A	W91-11149 5E
Personal Computer System Supporting Water Quality Management in Eutrophicated Bay.	W91-10003	
W91-10582 5G	COLONIZATION	Effects of Sewage Sludge and Waste Composi
W 71-10502	Regulatory Influence of Water Current on Algal	on Some Soil Enzymatic Activities Tested in a
Management of the Marine Environment in	Colonization in an Unshaded Stream at Shillong	Field Experiment.
Western Australia: An Ecosystem Approach.	(Meghalaya, India).	W91-11151 5E
W91-10583 5G	W91-11451 2E	Existing Conditions for Agricultural Utilization
Conceptual Framework of Environmental Man-	COLOR	of Sewage Sludge Compost in Japan.
agement Strategies for Yugoslavia: The Case of	Secchi Disk and Photometer Estimates of Light	W91-11152 5E
the Adriatic Sea.	Regimes in Alaskan Lakes: Effects of Yellow	
W91-10584 5G	Color and Turbidity.	Production of Compost from Sewage Sludge in
	W91-10860 2H	Tokyo.
'Parque de Donana', and Its Contribution to		W91-11153 5E
Environmental Activities for Environmental Protection.	COLOR REMOVAL	COMPRESSIBILITY
W91-10586 5G	Colour Removal from Textile Effluents by Ad-	Change in Pore Size Distribution Owing to Sec
W 71-10300	sorption Techniques. W91-11323 5D	ondary Consolidation of Clays.
Citizen's Movements to Protect the Environ-	W91-11323 3D	W91-10774 8E
ment of Rivers Flowing into the Seto Inland	COLORADO	77710774
Sea: An Example of a Citizen's Movement	Comparison of Nocturnal Drainage Flow in	COMPUTER-AIDED DESIGN
Along the Toga River.	Three Tributaries.	Deterministic Computer-Aided Optimum
W91-10587 5G	W91-10501 2E	Design of Rock Rubble-Mound Breakwate
National Estuary Program and Public Involve-	Macroinvertebrate Responses along a Complex	Cross-Sections.
ment.		W91-10785 8A
	Regulated Stream Environmental Gradient	
W91-10590 5G	Regulated Stream Environmental Gradient. W91-10848 4A	COMPLETED MODELS
W91-10590 5G	Regulated Stream Environmental Gradient. W91-10848 4A	COMPUTER MODELS  Uncertainty Analysis for a Linear Programmin
W91-10590 5G Improved Policy Instruments for Management	W91-10848 4A Water Market in the Southern Front Range of	Uncertainty Analysis for a Linear Programming
W91-10590 5G Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The	W91-10848 4A Water Market in the Southern Front Range of Colorado.	Uncertainty Analysis for a Linear Programmin Model for Acid Rain Abatement.
W91-10590 5G  Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA.	W91-10848 4A Water Market in the Southern Front Range of	Uncertainty Analysis for a Linear Programmin Model for Acid Rain Abatement.
W91-10590 5G Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L	W91-10848 4A Water Market in the Southern Front Range of Colorado. W91-11055 6D	Uncertainty Analysis for a Linear Programming Model for Acid Rain Abatement.
W91-10590 5G Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L Legal System and Management of Southern	W91-10848 4A  Water Market in the Southern Front Range of Colorado. W91-11055 6D  COLORADO RIVER BASIN	Uncertainty Analysis for a Linear Programmin, Model for Acid Rain Abatement. W91-10470 76 Mathematical Simulation of Pollutant Dispersion.
W91-10590 5G  Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L  Legal System and Management of Southern France Lagoons.	W91-10848 4A Water Market in the Southern Front Range of Colorado. W91-11055 6D	Uncertainty Analysis for a Linear Programmin, Model for Acid Rain Abatement. W91-10470 76 Mathematical Simulation of Pollutant Disper
W91-10590 5G Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L Legal System and Management of Southern	W91-10848 4A  Water Market in the Southern Front Range of Colorado. W91-11055 6D  COLORADO RIVER BASIN Legal Regimes for Interstate Water Allocation	Uncertainty Analysis for a Linear Programmin, Model for Acid Rain Abatement. W91-10470 76 Mathematical Simulation of Pollutant Dispersion. W91-10488 51
W91-10590 5G  Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L  Legal System and Management of Southern France Lagoons.	W91-10848  Water Market in the Southern Front Range of Colorado. W91-11055  COLORADO RIVER BASIN Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes	Uncertainty Analysis for a Linear Programmin, Model for Acid Rain Abatement. W91-10470 Mathematical Simulation of Pollutant Dispersion. W91-10488 51 Mathematical Modelling for Reservoir Water
W91-10590 5G  Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L  Legal System and Management of Southern France Lagoons. W91-10611 5G  COASTS  Effects of Oil Pollution on Bio-Ecology and	W91-10848  Water Market in the Southern Front Range of Colorado. W91-11055  COLORADO RIVER BASIN Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes and Failures. W91-11008  6E	Uncertainty Analysis for a Linear Programmin, Model for Acid Rain Abatement.  W91-10470 76  Mathematical Simulation of Pollutant Dispersion.  W91-10488 55  Mathematical Modelling for Reservoir Water Quality Management Through Hydraulic Struc
W91-10590 5G  Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L  Legal System and Management of Southern France Lagoons. W91-10611 5G  COASTS  Effects of Oil Pollution on Bio-Ecology and Fisheries on Certain Enclosed Coastal Regions	W91-10848  Water Market in the Southern Front Range of Colorado. W91-11055  COLORADO RIVER BASIN Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes and Failures. W91-11008  6E COLUMBIA PLATEAU AQUIFER SYSTEM	Uncertainty Analysis for a Linear Programmin, Model for Acid Rain Abatement. W91-10470 76 Mathematical Simulation of Pollutant Dispersion. W91-10488 51 Mathematical Modelling for Reservoir Water Quality Management Through Hydraulic Structures: A Case Study.
W91-10590 5G  Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L  Legal System and Management of Southern France Lagoons. W91-10611 5G  COASTS  Effects of Oil Pollution on Bio-Ecology and Fisheries on Certain Enclosed Coastal Regions of Arabian Sea.	W91-10848  Water Market in the Southern Front Range of Colorado. W91-11055  COLORADO RIVER BASIN Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes and Failures. W91-11008  COLUMBIA PLATEAU AQUIFER SYSTEM Geologic Framework of the Columbia Plateau	Uncertainty Analysis for a Linear Programmin, Model for Acid Rain Abatement.  W91-10470 76  Mathematical Simulation of Pollutant Dispersion.  W91-10488 55  Mathematical Modelling for Reservoir Water Quality Management Through Hydraulic Structures: A Case Study.  W91-10490 56
W91-10590 5G  Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L  Legal System and Management of Southern France Lagoons. W91-10611 5G  COASTS  Effects of Oil Pollution on Bio-Ecology and Fisheries on Certain Enclosed Coastal Regions	W91-10848  Water Market in the Southern Front Range of Colorado. W91-11055  6D  COLORADO RIVER BASIN  Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes and Failures. W91-11008  COLUMBIA PLATEAU AQUIFER SYSTEM  Geologic Framework of the Columbia Plateau Aquifer System, Washington, Oregon, and	Uncertainty Analysis for a Linear Programmin, Model for Acid Rain Abatement.  W91-10470 74  Mathematical Simulation of Pollutant Dispersion.  W91-10488 55  Mathematical Modelling for Reservoir Water Quality Management Through Hydraulic Structures: A Case Study.  W91-10490 56
W91-10590 5G  Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L  Legal System and Management of Southern France Lagoons. W91-10611 5G  COASTS  Effects of Oil Pollution on Bio-Ecology and Fisheries on Certain Enclosed Coastal Regions of Arabian Sea. W91-10555 5B	W91-10848  Water Market in the Southern Front Range of Colorado. W91-11055  6D  COLORADO RIVER BASIN Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes and Failures. W91-11008  6E  COLUMBIA PLATEAU AQUIFER SYSTEM Geologic Framework of the Columbia Plateau Aquifer System, Washington, Oregon, and Idaho.	Uncertainty Analysis for a Linear Programmin, Model for Acid Rain Abatement.  W91-10470  Mathematical Simulation of Pollutant Dispersion.  W91-10488  Mathematical Modelling for Reservoir Water Quality Management Through Hydraulic Structures: A Case Study.  W91-10490  50  Advances in Wind and Water Erosion Prediction.
W91-10590 5G  Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L  Legal System and Management of Southern France Lagoons. W91-10611 5G  COASTS  Effects of Oil Pollution on Bio-Ecology and Fisheries on Certain Enclosed Coastal Regions of Arabian Sea. W91-10555 5B  Simulation of Bioecological and Water Quality	W91-10848  Water Market in the Southern Front Range of Colorado. W91-11055  6D  COLORADO RIVER BASIN Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes and Failures. W91-11008  6E  COLUMBIA PLATEAU AQUIFER SYSTEM Geologic Framework of the Columbia Plateau Aquifer System, Washington, Oregon, and Idaho. W91-11571  2F	Uncertainty Analysis for a Linear Programmin, Model for Acid Rain Abatement.  W91-10470 76  Mathematical Simulation of Pollutant Dispersion.  W91-10488 51  Mathematical Modelling for Reservoir Water Quality Management Through Hydraulic Structures: A Case Study.  W91-10490 56  Advances in Wind and Water Erosion Predict
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W91-10590 5G  Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L  Legal System and Management of Southern France Lagoons. W91-10611 5G  COASTS  Effects of Oil Pollution on Bio-Ecology and Fisheries on Certain Enclosed Coastal Regions of Arabian Sea. W91-10555 5B  Simulation of Bioecological and Water Quality Processes in Enclosed Coastal Seas. W91-10557 5C  Engineering Geology of Nearshore Areas off Richards Island, N.W.T.: A Comparison of Stable and Actively Eroding Coastlines.	W91-10848  Water Market in the Southern Front Range of Colorado. W91-11055  COLORADO RIVER BASIN Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes and Failures. W91-11008  COLUMBIA PLATEAU AQUIFER SYSTEM Geologic Framework of the Columbia Plateau Aquifer System, Washington, Oregon, and Idaho. W91-11571  COLUMBIA RIVER Confirmatory Chemical Analyses and Solid Phase Bioassays on Sediment from the Columbia River Estuary at Tongue Point, Oregon. W91-10753  5B	Uncertainty Analysis for a Linear Programmin, Model for Acid Rain Abatement.  W91-10470  Mathematical Simulation of Pollutant Dispersion.  W91-10488  Mathematical Modelling for Reservoir Water Quality Management Through Hydraulic Structures: A Case Study.  W91-10490  Advances in Wind and Water Erosion Prediction.  W91-10509  RUSLE: Revised Universal Soil Loss Equation W91-10510  WEPP: A New Generation of Erosion Prediction Technology.
W91-10590 5G  Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L  Legal System and Management of Southern France Lagoons. W91-10611 5G  COASTS  Effects of Oil Pollution on Bio-Ecology and Fisheries on Certain Enclosed Coastal Regions of Arabian Sea. W91-10555 5B  Simulation of Bioecological and Water Quality Processes in Enclosed Coastal Seas. W91-10557 5C  Engineering Geology of Nearshore Areas off Richards Island, N.W.T.: A Comparison of Stable and Actively Eroding Coastlines. W91-10944 2J  COD  Immunochemical Detection of Cytochrome	W91-10848  Water Market in the Southern Front Range of Colorado. W91-11055  COLORADO RIVER BASIN Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes and Failures. W91-11008  COLUMBIA PLATEAU AQUIFER SYSTEM Geologic Framework of the Columbia Plateau Aquifer System, Washington, Oregon, and Idaho. W91-11571  COLUMBIA RIVER Confirmatory Chemical Analyses and Solid Phase Bioassays on Sediment from the Columbia River Estuary at Tongue Point, Oregon. W91-10753  COMBINED SEWER OVERFLOWS	Uncertainty Analysis for a Linear Programming Model for Acid Rain Abatement.  W91-10470 70  Mathematical Simulation of Pollutant Dispersion.  W91-10488 51  Mathematical Modelling for Reservoir Water Quality Management Through Hydraulic Structures: A Case Study.  W91-10490 50  Advances in Wind and Water Erosion Prediction.  W91-10509 2  RUSLE: Revised Universal Soil Loss Equation W91-10510 2  WEPP: A New Generation of Erosion Prediction Technology.  W91-10511 2  WEPP: Soil Erodibility Experiments for Range
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W91-10590 5G  Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L  Legal System and Management of Southern France Lagoons. W91-10611 5G  COASTS  Effects of Oil Pollution on Bio-Ecology and Fisheries on Certain Enclosed Coastal Regions of Arabian Sea. W91-10555 5B  Simulation of Bioecological and Water Quality Processes in Enclosed Coastal Seas. W91-10557 5C  Engineering Geology of Nearshore Areas off Richards Island, N.W.T.: A Comparison of Stable and Actively Eroding Coastlines. W91-10944 2J  COD  Immunochemical Detection of Cytochrome P450IA1 Induction in Cod Larvae and Juveniles Exposed to a Water Soluble Fraction of North	W91-10848  Water Market in the Southern Front Range of Colorado. W91-11055  COLORADO RIVER BASIN Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes and Failures. W91-11008  COLUMBIA PLATEAU AQUIFER SYSTEM Geologic Framework of the Columbia Plateau Aquifer System, Washington, Oregon, and Idaho. W91-11571  COLUMBIA RIVER Confirmatory Chemical Analyses and Solid Phase Bioassays on Sediment from the Columbia River Estuary at Tongue Point, Oregon. W91-10753  COMBINED SEWER OVERFLOWS Dynamic Simulation of Storm Tanks. W91-10928  COMMENCEMENT BAY/TACOMA SITE	Uncertainty Analysis for a Linear Programmin, Model for Acid Rain Abatement.  W91-10470  Mathematical Simulation of Pollutant Dispersion.  W91-10488  Mathematical Modelling for Reservoir Water Quality Management Through Hydraulic Structures: A Case Study.  W91-10490  Advances in Wind and Water Erosion Prediction.  W91-10509  RUSLE: Revised Universal Soil Loss Equation W91-10510  WEPP: A New Generation of Erosion Prediction Technology.  W91-10511  WEPP: Soil Erodibility Experiments for Rangeland and Cropland Soils.
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W91-10590 5G  Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L  Legal System and Management of Southern France Lagoons. W91-10611 5G  COASTS  Effects of Oil Pollution on Bio-Ecology and Fisheries on Certain Enclosed Coastal Regions of Arabian Sea. W91-10557 5B  Simulation of Bioecological and Water Quality Processes in Enclosed Coastal Seas. W91-10557 5C  Engineering Geology of Nearshore Areas off Richards Island, N.W.T.: A Comparison of Stable and Actively Eroding Coastlines. W91-10944 2J  COD  Immunochemical Detection of Cytochrome P450IA1 Induction in Cod Larvae and Juveniles Exposed to a Water Soluble Fraction of North Sea Crude Oil. W91-10871 5A	W91-10848  Water Market in the Southern Front Range of Colorado. W91-11055  COLORADO RIVER BASIN Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes and Failures. W91-11008  6E  COLUMBIA PLATEAU AQUIFER SYSTEM Geologic Framework of the Columbia Plateau Aquifer System, Washington, Oregon, and Idaho. W91-11571  COLUMBIA RIVER Confirmatory Chemical Analyses and Solid Phase Bioassays on Sediment from the Columbia River Estuary at Tongue Point, Oregon. W91-10753  COMBINED SEWER OVERFLOWS Dynamic Simulation of Storm Tanks. W91-10928  COMMENCEMENT BAY/TACOMA SITE Superfund Record of Decision: Commencement	Uncertainty Analysis for a Linear Programmin, Model for Acid Rain Abatement. W91-10470 70 Mathematical Simulation of Pollutant Dispersion. W91-10488 51 Mathematical Modelling for Reservoir Water Quality Management Through Hydraulic Structures: A Case Study. W91-10490 50 Advances in Wind and Water Erosion Prediction. W91-10509 2 RUSLE: Revised Universal Soil Loss Equation W91-10510 2 WEPP: A New Generation of Erosion Prediction Technology. W91-10511 2 WEPP: Soil Erodibility Experiments for Rangeland and Cropland Soils. W91-10512 2 Three-Dimensional Simulation of Airflow and Carlon American Simulation of Airflow and Carlon Simulation of Airflow Airflow Airflow Airflow Airflow Airflow Ai
W91-10590 5G  Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L  Legal System and Management of Southern France Lagoons. W91-10611 5G  COASTS  Effects of Oil Pollution on Bio-Ecology and Fisheries on Certain Enclosed Coastal Regions of Arabian Sea. W91-10555 5B  Simulation of Bioecological and Water Quality Processes in Enclosed Coastal Seas. W91-10557 5C  Engineering Geology of Nearshore Areas off Richards Island, N.W.T.: A Comparison of Stable and Actively Eroding Coastlines. W91-10944 2J  COD  Immunochemical Detection of Cytochrome P450IA1 Induction in Cod Larvae and Juveniles Exposed to a Water Soluble Fraction of North Sea Crude Oil. W91-10871 5A	W91-10848  Water Market in the Southern Front Range of Colorado. W91-11055  COLORADO RIVER BASIN  Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes and Failures. W91-11008  COLUMBIA PLATEAU AQUIFER SYSTEM Geologic Framework of the Columbia Plateau Aquifer System, Washington, Oregon, and Idaho. W91-11571  COLUMBIA RIVER Confirmatory Chemical Analyses and Solid Phase Bioassays on Sediment from the Columbia River Estuary at Tongue Point, Oregon. W91-10753  COMBINED SEWER OVERFLOWS Dynamic Simulation of Storm Tanks. W91-10928  COMMENCEMENT BAY/TACOMA SITE Superfund Record of Decision: Commencement Bay/S. Tacoma, WA.	Uncertainty Analysis for a Linear Programming Model for Acid Rain Abatement.  W91-10470  Mathematical Simulation of Pollutant Dispersion.  W91-10488  Mathematical Modelling for Reservoir Water Quality Management Through Hydraulic Structures: A Case Study.  W91-10490  Advances in Wind and Water Erosion Prediction.  W91-10509  RUSLE: Revised Universal Soil Loss Equation W91-10510  WEPP: A New Generation of Erosion Prediction Technology.  W91-10511  WEPP: Soil Erodibility Experiments for Rangeland and Cropland Soils.  W91-10512  Three-Dimensional Simulation of Airflow an Orographic Rain Over the Island of Hawai W91-10517
W91-10590 5G  Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L  Legal System and Management of Southern France Lagoons. W91-10611 5G  COASTS  Effects of Oil Pollution on Bio-Ecology and Fisheries on Certain Enclosed Coastal Regions of Arabian Sea. W91-10557 5B  Simulation of Bioecological and Water Quality Processes in Enclosed Coastal Seas. W91-10557 5C  Engineering Geology of Nearshore Areas off Richards Island, N.W.T.: A Comparison of Stable and Actively Eroding Coastlines. W91-10944 2J  COD  Immunochemical Detection of Cytochrome P450IA1 Induction in Cod Larvae and Juveniles Exposed to a Water Soluble Fraction of North Sea Crude Oil. W91-10871 5A	W91-10848  Water Market in the Southern Front Range of Colorado. W91-11055  COLORADO RIVER BASIN Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes and Failures. W91-11008  6E  COLUMBIA PLATEAU AQUIFER SYSTEM Geologic Framework of the Columbia Plateau Aquifer System, Washington, Oregon, and Idaho. W91-11571  2F  COLUMBIA RIVER Confirmatory Chemical Analyses and Solid Phase Bioassays on Sediment from the Columbia River Estuary at Tongue Point, Oregon. W91-10753  COMBINED SEWER OVERFLOWS Dynamic Simulation of Storm Tanks. W91-10928  COMMENCEMENT BAY/TACOMA SITE Superfund Record of Decision: Commencement Bay/S. Tacoma, WA. W91-10711  5G	Uncertainty Analysis for a Linear Programmin, Model for Acid Rain Abatement. W91-10470 70 Mathematical Simulation of Pollutant Dispersion. W91-10488 51 Mathematical Modelling for Reservoir Water Quality Management Through Hydraulic Structures: A Case Study. W91-10490 50 Advances in Wind and Water Erosion Prediction. W91-10509 20 RUSLE: Revised Universal Soil Loss Equation W91-10510 WEPP: A New Generation of Erosion Prediction Technology. W91-10511 20 WEPP: Soil Erodibility Experiments for Ranguland and Cropland Soils. W91-10512 Three-Dimensional Simulation of Airflow and Orographic Rain Over the Island of Hawa W91-10517 2
W91-10590 5G  Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA. W91-10610 2L  Legal System and Management of Southern France Lagoons. W91-10611 5G  COASTS  Effects of Oil Pollution on Bio-Ecology and Fisheries on Certain Enclosed Coastal Regions of Arabian Sea. W91-10555 5B  Simulation of Bioecological and Water Quality Processes in Enclosed Coastal Seas. W91-10557 5C  Engineering Geology of Nearshore Areas off Richards Island, N.W.T.: A Comparison of Stable and Actively Eroding Coastlines. W91-10944 2J  COD  Immunochemical Detection of Cytochrome P450IA1 Induction in Cod Larvae and Juveniles Exposed to a Water Soluble Fraction of North Sea Crude Oil. W91-10871 5A  COEFFICIENT OF CONSOLIDATION Graphical Method for Determining the Coeffi-	W91-10848  Water Market in the Southern Front Range of Colorado. W91-11055  COLORADO RIVER BASIN  Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes and Failures. W91-11008  COLUMBIA PLATEAU AQUIFER SYSTEM Geologic Framework of the Columbia Plateau Aquifer System, Washington, Oregon, and Idaho. W91-11571  COLUMBIA RIVER Confirmatory Chemical Analyses and Solid Phase Bioassays on Sediment from the Columbia River Estuary at Tongue Point, Oregon. W91-10753  COMBINED SEWER OVERFLOWS Dynamic Simulation of Storm Tanks. W91-10928  COMMENCEMENT BAY/TACOMA SITE Superfund Record of Decision: Commencement Bay/S. Tacoma, WA. W91-10711  COMMUNITY DEVELOPMENT	Uncertainty Analysis for a Linear Programming Model for Acid Rain Abatement.  W91-10470 70  Mathematical Simulation of Pollutant Dispersion.  W91-10488 51  Mathematical Modelling for Reservoir Water Quality Management Through Hydraulic Structures: A Case Study.  W91-10490 50  Advances in Wind and Water Erosion Prediction.  W91-10509 20  RUSLE: Revised Universal Soil Loss Equation W91-10510 20  WEPP: A New Generation of Erosion Prediction Technology.  W91-10511 20  WEPP: Soil Erodibility Experiments for Rangeland and Cropland Soils.  W91-10512 20  Three-Dimensional Simulation of Airflow an Orographic Rain Over the Island of Hawai W91-10517 20  Computer Visualization System for Sedimer Pollution in Japan.

## COMPUTER MODELS

Preconditioned Conjugate-Gradient 2 (PCG2),	Soil Tec: A Computerized Soil-Specific Fertiliz-	CONFERENCES
A Computer Program for Solving Ground-	er Application System.	Health-Related Water Microbiology 1990.
Water Flow Equations.	W91-11197 7C	W91-10612 5F
W91-10764 7C	COMPUTERIZED MAPS	Agrichemicals and Groundwater Protection:
Computer Modeling of Scale Formation During	Oil Spill Risk Simulation Model.	Resources and Strategies for State and Local
Treatment of Ground Water in Air Strippers.	W91-11001 5B	Management.
W91-10798 5G	ATLAS*GRAPHICS: An Affordable Mapping	W91-11162 5G
Embedding and Response Matrix Techniques for	System.	COMPANYOR INTERNATO
Maximizing Steady-State Ground-Water Extrac-	W91-11175 7C	CONFIDENCE INTERVALS  LC-50 Estimates and Their Confidence Intervals
tion; Computational Comparison.		Derived for Tests with Only One Concentration
W91-10954 2F	COMPUTERS	with Partial Effect.
Method to Determine the Formation Constants	AgriSource: The Information System for Crop Technology.	W91-10930 5C
of Leaky Aquifers, and Its Application to Pump-	W91-11196 10D	
ing Test Data.	W711170	CONFINED AQUIFERS
W91-10961 7C	Solution in Closed Form and a Series Solution to	Embedding and Response Matrix Techniques for Maximizing Steady-State Ground-Water Extrac-
Stadio A	Replace the Tables for the Thickness of the	tion; Computational Comparison.
Studies on Assessment of Water Balance and Its Quality in Gurpur River Basin, Karnataka State,	Equivalent Layer in Hooghoudt's Drain Spacing Formula.	W91-10954 2F
India.	W91-11430 2G	
W91-11065 5B		Environmental Isotope Study for Estimating
	CONCEPCION	Leakage and Runoff of Ground Waters in the Xi'an Area.
Effects of Land Use Alteration on Tropical	Fish Fauna of Various Bodies of Stagnant Water	W91-10994 2F
Carbon Exchange. W91-11072 4C	Near Concepcion (Paraguay) (Zur Fischfauna Einiger Stehender Gewasser bei Concepcion	1171-10774
W91-110/2	(Paraguay)).	Maps of the '400-foot,' '600-foot,' and Adjacent
Solution in Closed Form and a Series Solution to	W91-11523 2H	Aquifers and Confining Beds, Baton Rouge
Replace the Tables for the Thickness of the		Area, Louisiana.
Equivalent Layer in Hooghoudt's Drain Spacing	CONCRETE	W91-11086 2F
Formula. W91-11430 2G	Predicting Concrete Service Life in Cases of	Response of Water Level in a Well to a Time
W91-11430 2G	Deterioration Due to Freezing and Thawing. W91-10734 8F	Series of Atmospheric Loading Under Confined
Characterization and Simulation of Rainfall-	W 71-10/34	Conditions.
Runoff Relations for Headwater Basins in West-	CONCRETE CONSTRUCTION	W91-11236 2F
ern King and Snohomish Counties, Washington.	Testing of Cellular Concrete Revetment Blocks	CONFLICTING USE
W91-11592 2A	Resistant to Growths of Reynoutria japonica	Milk River: Historical Transitions in an Interna-
COMPUTER PROGRAMS	Houtt (Japanese Knotweed). W91-10942 8F	tional Waterway.
Properties of Linear Programming Models for	1171-10742	W91-11039 6E
Acid Rain Abatement.	CONCRETE DAMS	
W91-10477 5G	Nonlinear Earthquake Response of Concrete	CONJUNCTIVE USE
WEPP: A New Generation of Erosion Predic-	Gravity Dam Systems.	Evaluation of Three Scenarios of Ground-Water
tion Technology.	W91-10754 8F	Withdrawal from the Mississippi River Alluvial Aquifer in Northwestern Mississippi.
W91-10511 2J	Seismic Fracture Analysis of Concrete Gravity	W91-11106 4B
	Dams.	
Personal Computer System Supporting Water	W91-10787 8F	Abbeystead Outfall Works: Background to Re-
Quality Management in Eutrophicated Bay. W91-10582 5G	CONCRETE PIPES	pairs and Modifications and Lessons Learned.
W 91-10302	Roughness Coefficients of Watercourse Revet-	W91-11355 5D
Computer Visualization System for Sediment	ted With Half-Circular Concrete Pipes. Results	CONSERVATION
Pollution in Japan.	of Field Measurements in Watercourse S 333 at	Seagrass-Mangrove Ecosystems Management: A
W91-10609 7C	Maarkedal.	Key to Marine Coastal Conservation in the
Preconditioned Conjugate-Gradient 2 (PCG2),	W91-11431 8B	ASEAN Region.
A Computer Program for Solving Ground-	CONCRETES	W91-10539 5G
Water Flow Equations.	Rocking Armour Units: Number, Location and	Environmental Activism in the San Francisco
W91-10764 7C	Impact Velocity.	Bay Estuary.
Deterministic Computer-Aided Optimum	W91-10786 8A	W91-10585 5G
Design of Rock Rubble-Mound Breakwater	CONDUCTANCE	
Cross-Sections.	Rainfall Interception and Boundary Layer Con-	Economic Assessment of the Water Quality Ben-
W91-10785 8A	ductance in Relation to Tree Spacing.	efits of Conservation Tillage on Southwestern Ontario Cropland.
	W91-10905 2I	W91-11050 3F
Fast Algorithm for Automatically Computing Strahler Stream Order.	CONDUCTIVITY	
W91-10818 2J	Continuous Flow Thin-Layer Headspace	Land Tenure Issues in Watershed Development.
471-10010	(TLHS) Analysis. I. Conductometric Determi-	W91-11569 6F
Method to Determine the Formation Constants	nation of Volatile Organic Halogens (VOX) in	CONSERVATION TILLAGE
of Leaky Aquifers, and Its Application to Pump-	Tap Water.	Economic Assessment of the Water Quality Ben-
ing Test Data. W91-10961 7C	W91-11256 5A	efits of Conservation Tillage on Southwestern
W91-10961 7C	Effect of Low Salinity Water on Salt Displace-	Ontario Cropland.
Soil Survey Information System: A User Friend-	ment in Two Soils.	W91-11050 3F
ly Soil Information System.	W91-11433 2G	CONSOLIDATION
W91-11174 7C		CONSOLIDATION Graphical Method for Determining the Coeffi
ATLAS*GRAPHICS: An Affordable Mapping	Conductivity for Nutrient Control In CTMP	cient of Consolidation cv from a Flow-Pump
System.	Wastewater Treatment. W91-11495 5D	Permeability Test.
W91-11175 7C	30	W91-11393 7C
	CONESTOGA RIVER BASIN	
Crop Data Management Systems, Inc. Meeting	Nutrient Loading Status of the Conestoga River	CONSTRUCTION  Posteria Confell
California's Pesticide Regulation Challenge. W91-11177	Basin, 1985-1989. W91-11599	Boston's Sewage Outfall.

Kansai International Airport Project and Envi- ronmental Impact Assessment. W91-10563 4C	CORE ANALYSIS Polychlorinated Biphenyls in Dated Sediment Cores from Green Bay and Lake Michigan.	Funding Groundwater Protection Programs: Iowa's Groundwater Protection Fund. W91-11179 5G
	W91-10979 5B	
CONTAINMENT BOOMS		COULOMETRY
Remediation of Floating, Open Water Oil Spills:	CORES	Coulometric Measurement of Primary Produc-
Comparative Efficacy of Commercially Avail-	Analysis of Ground-Probing Radar Data: Pre-	tion, with Comparison against Dissolved
able Polypropylene Sorbent Booms.	dictive Deconvolution.	Oxygen and 14-C Methods in a Seasonal Study.
W91-11447 5G	W91-10782 8G	W91-10868 2L
CONTENOT CERTICETIBES	Correlated Oceania and Continental Become	CRAYFISH
CONTROL STRUCTURES	Correlated Oceanic and Continental Records Demonstrate Past Climate and Hydrology of	
Change of Oceanic Condition by the Man-Made	North Africa (0-140 ka).	Biochemical and Histochemical Observations on
Structure for Upwelling.	W91-10788 2B	Effects of Low-Level Metal Load (Lead, Cad-
W91-10542 8I	W91-10/66 2B	mium) in Different Organ Systems of the Fresh-
CONTROL SYSTEMS	Organic Carbon Accumulation in Baffin Bay	water Crayfish, Astacus astacus L. (Crustacea: Decapoda).
	and Paleoenvironment in High Northern Lati-	
Experience with Low-Head HydroPlant Fre-	tudes During the Past 20 m. y.	W91-10827 5B
quency Control. W91-11214 8C	W91-10791 2J	CREDIT RIVER BASIN
W91-11214 8C		Comprehensive Water Management Strategy:
CONVECTIVE PRECIPITATION	CORN	Credit River Watershed.
Convective Cell in a Hurricane Rainband.	Effects of Drought Stress and Simulated Acidic	W91-11043 6A
W91-11422 2B	Rain on Foliar Conductance of Zea mays L.	77
1171-11722	W91-10919 5C	CROP PRODUCTION
COOLING TOWERS	CORRECTION COEFFICIENTS	Challenge of Sustaining Productivity in the Face
Occurrence of Legionella Bacteria in Cooling		of CO2-Induced Change.
Towers in South Africa.	Correction Coefficients for Uniform Channel	W91-11073 5C
W91-10641 5B	Flow.	
	W91-11282 2E	CROP YIELD
COOLING WATER	CORRELATION ANALYSIS	Production Functions Relating Crop Yield,
Comprehensive Cooling Water Study, Final	Empirical Method of Estimating Raingage and	Water Quality and Quantity, Soil Salintiy and
Report. Volume I: Summary of Environmental	Radar Rainfall Measurement Bias and Resolu-	Drainage Volume.
Effects.	tion.	W91-11434 3C
W91-10729 5B	W91-11409 2B	T : 11 T :
		Trickle Irrigation of Sunflower With Municipal Wastewater.
COOPERATIVE WATER RESOURCES	COST ALLOCATION	
PROGRAM	Funding New York State's Integrated Pest Man-	W91-11435 3F
U.S. Geological Survey Federal-State Coopera-	agement Program.	CROPS
tive Water-Resources Program Fiscal Year 1989.	W91-11180 6C	Water Use of a Winter Wheat Cultivar (Triti-
W91-11109 7B		cum Aestivum).
ACRES CONT.	COST ANALYSIS	W91-11436 3F
COPENHAGEN	Properties of Linear Programming Models for	W 21-11430 31
Measures for Purification of the Leachate from	Acid Rain Abatement.	CRUSTACEANS
'Renseanlaeg Damhusaen' into Copenhagen	W91-10477 5G	Effects of Pollution on Heterozygosity in the
Waters, to Meet the NPO-Plan.	Removal of Heavy Metals from Sewage Sludge:	Barnacle Balanus amphitrite (Cirripedia: Thora-
W91-10601 5D	State of the Art and Perspectives.	cica).
COPEPODS	W91-11124 5D	W91-10518 5C
Assimilation of Metals in Marine Copepods and	1171-11124	
its Biogeochemical Implications.	COST-BENEFIT ANALYSIS	CRYOSPHERE
W91-10866 2L	Costs and Benefits of Moving to Peak-Load	Cloud/Cryosphere Interactions.
W 51-10000 2L	Pricing for Municipally-Supplied Water.	W91-11095 2B
COPPER	W91-11047 6C	CRYPTOSPORIDIUM
Effect of a Spring Phytoplankton Bloom on		Thames Water's Experiences with Cryptospori-
Dissolved Copper Speciation in Bedford Basin.	Economic Assessment of the Water Quality Ben-	dium.
W91-10543 5B	efits of Conservation Tillage on Southwestern	W91-10617 5C
	Ontario Cropland.	W91-10017
Effects of Copper and Tributyltin on Stress Pro-	W91-11050 3F	Epidemiology of Human Cryptosporidiosis and
tein Abundance in the Rotifer Brachionus plica-	Micro-Targeting Cropland Retirement for	
tilis.	Water Quality Improvement: Measuring the	
W91-10900 5C	Benefits of Increased Information.	
	W91-11052 3F	Isolation and Identification of Cryptosporidium
Remobilization of Cu from Marine Particulate	W 91-11032 31	from Water.
Organic Matter and from Sewage.	Implications of Full-Cost Recovery Water Rates	W91-10644 5A
W91-10923 5B	on Irrigated Farms in Saskatchewan.	
District of District Catalog Last and	W91-11054 6C	Occurrence of Cryptosporidium spp. Oocysts in
Distribution of Dissolved Cadmium, Lead and		Scottish Waters, and the Development of
Copper in the Bristol Channel and the Outer	Economic Analysis of Off-Farm Soil Conserva-	Fluorogenic Viability Assay for Individua
Severn Estuary.	tion Structures.	Cryptosporidium Oocysts.
W91-10925 5B	W91-11567 4D	W91-10645 5E
Concentration of Metals in Various Larval	Enterior of Six Salastina Criteria Wall	Cryptosporidiosis and Water Supply: A Brie
Stages of Four Ephemeroptera Species.	Evaluation of Site-Selection Criteria, Well Design, Monitoring Techniques, and Cost Anal-	
W91-11302 5B	ysis for a Ground-Water Supply in Piedmont	
75-11502		W91-11271 51
Heavy Metal Distribution in the Godvari River	Crystalline Rocks, North Carolina. W91-11596 2F	
Basin.	W91-11596 2F	CRYSTAL GROWTH
W91-11445 5B	COSTS	Vapor Diffusional Growth of Free-Falling
	Costs and Benefits of Moving to Peak-Load	
CORD GRASSES	Pricing for Municipally-Supplied Water.	W91-10515 20
Seasonal Variation of Biomass and Production	W91-11047 6C	
Dynamics for Above and Belowground Compo-	W 71-11047	CRYSTALLINE ROCKS
nents of a Spartina alterniflora Marsh in the		Municipal Ground Water from Ancient Crystal
Euhaline Sector of Paranagua Bay (SE Brazil).		line Bedrock.
W91-10495 2L	W91-11175 7C	W91-10822 2I

2F

### CULTIVATION

CULTIVATION	CYPRUS	Geotechnical Appraisal of the Foundation Rock
Can Fauna Impoverishment Affect Humus Con-	Man-Made Garbage Pollution on the Mediterra-	Mass Behaviour of Narmada Sagar Dam
tent in Cultivated Soils (Czy ubozenie fauny	nean Coastline.	Project, Central India: A Case Study.
moze wplywac na zawartosc prochnicy w gle-		W91-10784 8E
	W91-10569 5B	W91-10/64 6E
bach uprawnych).	CZECHOSLOVAKIA	DANGED DIVED
W91-11543 2G		DANUBE RIVER
CULTURE MEDIA	Socio-Political Aspects of the Bos-Nagymaros	Danube River Basin: Negotiating Settlements to
	Barrage System.	Transboundary Environmental Issues.
Evaluation of Fecal Enterococci Isolation Media	W91-11217 6G	W91-11387 5G
to Indicate Fecal Pollution in Chlorinated		
Water.	DAM CONSTRUCTION	DANUBE RIVER BASIN
W91-10626 5F	Seismic Hazard at Narmada Sagar Dam.	Resolving Conflicts on the Danube: The Gabci-
	W91-10949 8E	kovo-Nagymaros Power Dam Project.
Production of Chironomid Larvae in Culturing	W 71-10347	W91-11018 6B
Media of Various Organic Wastes.	Method of Calculating the Technological Pa-	W91-11016 0D
W91-11526 8I		DATA ACQUICITION
	rameters When Designing Hydraulic-Fill Dams	DATA ACQUISITION
CULTURING TECHNIQUES	of Silty Soils.	ARCHIMEDES IIa Experiment on Oil Slick
Effect of Heat Shock on Recovery of Escheri-	W91-11284 8A	Detection over the North Sea-April 1988
chia coli from Drinking Water.		Measurement Results Obtained by the E-SAR
W91-10628 5F	DAM DESIGN	System of the German Aerospace Research Es-
1171 10000	Unit Hydrographs for Developing Design Flood	tablishment.
Miniaturized Fluorogenic Assays for Enumera-	Hydrographs.	W91-10742 5B
tion of E. coli and Enterococci in Marine Water.	W91-10809 2E	W 31-10/42 3D
W91-10639 5A		Analysis of Ground-Probing Radar Data: Pre-
W71-10037	DAM EFFECTS	
Most Probable Number Method for the Enu-		dictive Deconvolution.
	Macroinvertebrate Responses along a Complex	W91-10782 8G
meration of Legionella Bacteria in Water.	Regulated Stream Environmental Gradient.	*****
W91-10640 5A	W91-10848 4A	Utility of Multiple-Completion Monitoring
Growth of Clinical Isolates of Astronians in		Wells for Describing a Solvent Plume.
Growth of Clinical Isolates of Astrovirus in a	Socio-Political Aspects of the Bos-Nagymaros	W91-10800 7A
Cell Line and the Preparation of Viral RNA.	Barrage System.	
W91-10669 5A	W91-11217 6G	U.S. Geological Survey Federal-State Coopera-
	11.5.4.4.4.1	tive Water-Resources Program Fiscal Year 1989.
CULVERT FISHWAYS	Effect of Hydroelectric Stations on Water Qual-	W91-11109 7B
Hydraulics of Culvert Fishways IV: Spoiler	ity and Development of Phytoplankton in the	W91-11109 /B
Baffle Culvert Fishways.	Lower Pools of Reservoirs.	Methodology to Derive Water-Quality Trends
W91-11279 8I	W91-11289 6G	
	W71-11207	for Use by the National Water Summary Pro-
CULVERTS	Microzoobenthos of the River Jihlava After the	gram of the U.S. Geological Survey.
Melvin Price Locks and Dam Auxiliary Lock		W91-11110 7B
and Rotary Lock Culvert Valve, Mississippi	Construction of the Dalesice Waterworks.	
River, Alton, Illinois: Hydraulic Model Investi-	W91-11521 6G	Automatic Tracer-Dilution Method Used for
gation.		Stage-Discharge Ratings and Streamflow Hy-
W91-10723 8C	Upstream Extirpation of Four Minnow Species	drographs on Small Iowa Streams.
W71-10/23	Due to Damming of a Prairie Stream.	W91-11111 7B
CYANOPHYTA	W91-11535 6G	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Inhibition of NO3(-), NH4(+), and PO4(3-)		Minnesota District, Water Resources Division:
	DAM FAILURE	Information and Technical Assistance.
Uptake in Anabaena doliolum Exposed to a Pe-	Nonlinear Earthquake Response of Concrete	
troleum Oil.		W91-11167 2F
W91-10825 5C	Gravity Dam Systems.	
	W91-10754 8F	Planned Studies of Agrichemicals in Ground
Microcystis Changes its Buoyancy in Response		and Surface Water in the Mid-Continental
to the Average Irradiance in the Surface Mixed	Short-Term Effects of a Catastrophic Beaver	United States.
Layer.	Dam Collapse on a Stream Fish Community.	W91-11168 5B
W91-10895 2H	W91-11558 2E	
***		Optimal Data Acquisition Strategy for the De-
Microbial Mats in Tidal Channels at San Carlos,	DAM FOUNDATIONS	velopment of a Transport Model for Ground-
Baja California Sur, Mexico.	Geotechnical Appraisal of the Foundation Rock	water Remediation.
W91-11400 2L	Mass Behaviour of Narmada Sagar Dam	
		W91-11238 5G
CYCLING NUTRIENTS	Project, Central India: A Case Study.	Street Chemister in the France Miles Co.
Macroalgal-Sediment Nutrient Interactions and	W91-10784 8E	Stream Chemistry in the Eastern United States:
Their Importance to Macroalgal Nutrition in a	DAM SAFETY	1. Synoptic Survey Design, Acid-Base Status,
Eutrophic Estuary.	DAM SAFETY	and Regional Patterns.
	Seismic Hazard at Narmada Sagar Dam.	W91-11241 5B
W91-10497 2L	W91-10949 8E	
Eutrophication in Hissahima Dan		Hydrometric Data Collection and Interpretation
Eutrophication in Hiroshima Bay.	DAM STABILITY	in the Prairie Provinces and Northwest Territo-
W91-10536 5B	Nonlinear Earthquake Response of Concrete	ries.
Deleger of Nestricat I	Gravity Dam Systems.	W91-11278 7A
Balance of Nutrient Losses and Gains in Sea-	W91-10754 8F	W71*114/0 /A
grass Meadows.	1171°10/34 8F	Satellite Derived Reflectance of Security
W91-10867 2L	Geotechnical Appraisal of the Foundation Bush	Satellite-Derived Reflectance of Snow-Covered
	Geotechnical Appraisal of the Foundation Rock	Surfaces in Northern Minnesota.
Influence of pH on Phosphate Release from	Mass Behaviour of Narmada Sagar Dam	W91-11353 7C
Sediments.	Project, Central India: A Case Study.	
W91-11327 2H	W91-10784 8E	Relationship of MSS and TM Digital Data with
		Suspended Sediments, Chlorophyll, and Tem-
CYCLONIC PRECIPITATION	Seismic Fracture Analysis of Concrete Gravity	perature in Moon Lake, Mississippi.
Satellite-Derived Integrated Water-Vapor Dis-	Dams.	W91-11354 7C
tribution in Oceanic Midlatitude Storms: Varia-	W91-10787 8F	
tion with Region and Season.	V.	New Approach to Tracer Transport Analysis:
	DAMS	From Fracture Systems to Strongly Heterogene-
W91-11419 2B	Melvin Price Locks and Dam Auxiliary Lock	ous Porous Media.
Damemical Forcing and Massacala Occasionis	and Rotary Lock Culvert Valve, Mississippi	
Dynamical Forcing and Mesoscale Organization		W91-11554 2F
of Precipitation Bands in a Midwest Winter Cy-	River, Alton, Illinois: Hydraulic Model Investi-	
clonic Storm.	gation.	Levels at Streamflow Gaging Stations.
W91-11424 2B	W91-10723 8C	W91-11586 7B

DATA COLLECTIONS Status of Ground Water in the 1100 Area.	Hydrometric Data Collection and Interpretation in the Prairie Provinces and Northwest Territo-	Changing Dynamics of Interest Representation in Water Resources Management.
W91-10732 5B	ries.	W91-11007 6E
Preliminary Data Summary for the Hospitals	W91-11278 7A	Fluctuating Water Levels: An Issue Manage-
Point Source Category. W91-10738 5B	Application of Uphole Data from Petroleum Seismic Surveys to Groundwater Investigations, Abu Dhabi (United Arab Emirates).	ment Approach. W91-11033 6B
Preliminary Data Summary for the Pesticide Chemicals Point Source Category.	W91-11399 7C	Limits of Government Responsibility. W91-11034 6E
W91-10739 5B	Empirical Method of Estimating Raingage and Radar Rainfall Measurement Bias and Resolu-	Institutional Morass: Constraints and Opportuni-
Cooperative Data on Regional Water Use: The Great Lakes Regional Water Use Data Reposi- tory.	tion. W91-11409 2B	ties for Issue Management. W91-11036 6A
W91-11010 6D	Estimating Flow Characteristics at Ungauged Sites.	Water Diversion from the Great Lakes as a
Methodology to Derive Water-Quality Trends for Use by the National Water Summary Pro-	W91-11545 2E	Dynamic Game. W91-11051 6B
gram of the U.S. Geological Survey. W91-11110 7B	Analysis and Interpretation of the Borehole Televiewer Log: Information on the State of	Red River Basin Grass Roots Policy Process. W91-11185 6B
National Pesticide Usage Data Base.	Stress and the Lithostratigraphy at Hole 504B. W91-11549 7C	
W91-11176 7C	DATA MANAGEMENT	Decision Support System for Water Transfer Evaluation.
Preliminary Data Summary for the Machinery Manufacturing and Rebuilding Industry.	Development and Implementation of a Remedial Investigation Work Plan and Data Management	W91-11226 6A
W91-11589 5B	System. W91-10799 5G	DECOMPOSING ORGANIC MATTER Processing of Leaves of Trees and Aquatic Ma-
DATA INTERPRETATION	W71-10777	crophytes in the Network of the River Rhone.
ESCCP Cloud Data Products. W91-10479 2B	DATA PROCESSING Case Studies in Data Analysis.	W91-11402 2H
	W91-10733 2B	Can Fauna Impoverishment Affect Humus Con-
Investigation on Turbidity and Flow Patterns in Half-Closed Sea Area.	Soil Tec: A Computerized Soil-Specific Fertiliz-	tent in Cultivated Soils (Czy ubozenie fauny moze wplywac na zawartosc prochnicy w gle-
W91-10532 5B	er Application System. W91-11197 7C	bach uprawnych). W91-11543 2G
Case Studies in Data Analysis.		W91-11343
W91-10733 2B	DATA STORAGE AND RETRIEVAL Methodology to Derive Water-Quality Trends	DECOMPOSITION Reactive Continuum Representation of Organic
Effects of Land-Use Buffer Size on Spearman's	for Use by the National Water Summary Pro- gram of the U.S. Geological Survey.	Matter Diagenesis.
Partial Correlations of Land Use and Shallow Ground-Water Quality.	W91-11110 7B	W91-11448 2J
W91-10761 4C	Sail Survey Information System. A User Friend	DECONTAMINATION
Analysis of Ground-Probing Radar Data: Pre-	Soil Survey Information System: A User Friendly Soil Information System.	Effect of a Spring Phytoplankton Bloom or Dissolved Copper Speciation in Bedford Basin
dictive Deconvolution. W91-10782 8G	W91-11174 7C	W91-10543 5E
Modelling Water and Solute Transport in Ma-	National Pesticide Usage Data Base. W91-11176 7C	DEFORESTATION
croporous Soil. I. Model Description and Sensi-	DATABASES	Effects of Land Use Alteration on Tropica
tivity Analysis. W91-10803 5B	Development and Implementation of a Remedial	Carbon Exchange. W91-11072 4C
Comparison of Mean Annual Runoff Estimates	Investigation Work Plan and Data Management System.	Deforestation and Leaching of Nitrogen as Ni
in the Canadian Portion of the Great Lakes Basin.	W91-10799 5G	trates into Underground Water in Intertropica Zones: The Example of Cote d'Ivoire.
W91-11020 2E	Cooperative Data on Regional Water Use: The Great Lakes Regional Water Use Data Reposi-	W91-11446 2F
U.S. Geological Survey Federal-State Coopera-	tory.	DEGRADATION PRODUCTS
tive Water-Resources Program Fiscal Year 1989. W91-11109	W91-11010 6D	Behavior of the Fungicide MBAMT in Water W91-11315 5A
Methodology to Derive Water-Quality Trends	National Pesticide Usage Data Base. W91-11176 7C	Aqueous Photolysis of Napropamide.
for Use by the National Water Summary Pro-	Crop Data Management Systems, Inc. Meeting	W91-11376 51
gram of the U.S. Geological Survey. W91-11110 7B	California's Pesticide Regulation Challenge. W91-11177 5G	DEHALOGENATION
Minnesota District, Water Resources Division:		Electrolytic Model System for Reductive Deha logenation in Aqueous Environments.
Information and Technical Assistance. W91-11167 2F	DATING Geographical and Pollenanalytical Research of	W91-11343 51
Planned Studies of Agrichemicals in Ground	Lake Kleiner Barsch-See (Bez. Potsdam, GDR) (Geographische und Pollenanalytische Untersu-	Biological Dehalogenation of Kraft Mil
and Surface Water in the Mid-Continental United States.	chungen des Kleinen Barsch-Sees) (Bez. Pots- dam, DDR).	Wastewaters. W91-11497 5I
W91-11168 5B	W91-11514 2H	DEICERS
	DECHLORINATION	Road Salting Impacts in Massachusetts.
Soil Survey Information System: A User Friendly Soil Information System. W91-11174 7C	Investigation of Anaerobic Removal and Degra- dation of Organic Chlorine from Kraft Bleach-	W91-11053 44
	ing Wastewaters.	DELAWARE
Simulation of Precipitation by Weather Type	W91-11492 5D	Effect of Coastal Sea Level Forcing on India River Bay and Rehoboth Bay, Delaware.
Analysis. W91-11230 2B	DECISION MAKING	W91-10494 21
Geostatistical Characteristics of the Borden Aq-	Application of a Hazard Assessment Research Strategy to the Ocean Disposal of a Dredged	Superfund Record of Decision: Delaware San
uifer.	Material: Overview.	and Gravel, DE.
31/01 11024 2E	W01-10740 SF	W91-10717 50

### **DELAWARE RIVER BASIN**

Report of the River Master of the Delaware	DESALINATION Investigations With Electrodialysis Reversal for	<b>DETRITUS</b> Processing of Leaves of Trees and Aquatic Ma-
River, for the Period December 1, 1988-November 30, 1989.	the Treatment of Surface Water to Make-Up Water.	crophytes in the Network of the River Rhone. W91-11402 2H
W91-10765 4A	W91-11368 5F	
N. V.I. Cital Dalama Bira Bair	Regional Approach to Salinity Management in	DEVELOPING COUNTRIES
New York City's Delaware River Basin Supply-A Case Study in Interstate Coopera- tion	River Basins. A Case Study in Southern Iran. W91-11432 5G	Special Report: Water Supply and Sanitation. W91-10482 5F
W91-11046 6E	DESERTIFICATION	Lessons Learned from a Third World Water and
Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin.	Aral Sea Basin: A Critical Environmental Zone. W91-11441 6G	Sanitation Project. W91-10503 5F
W91-11060 5C	DESERTS	Surveillance Solutions to Microbiological Prob-
Simulation of Precipitation by Weather Type	Hydrogeologic Inferences from Drillers' Logs and from Gravity and Resistivity Surveys in the	lems in Water Quality Control in Developing Countries.
Analysis. W91-11230 2B	Amargosa Desert, Southern Nevada. W91-10996 5E	W91-10625 5G
DELAWARE SAND AND GRAVEL SITE	DESIGN CRITERIA	Water and Human Health.
Superfund Record of Decision: Delaware Sand	Criteria for Flocculator Design.	W91-11211 5F
and Gravel, DE.	W91-11269 5F	Unbesidentian and Unber Water Broblems in
W91-10717 5G		Urbanization and Urban Water Problems in Southeast Asia: A Case of Unsustainable Devel-
	DESIGN FLOODS	opment.
DELTAS Secondary Salinization of Soils of the Dniester	Update of Flood-Flow Characteristics of Nancy Creek at Georgia Highway 400 Extension Near	W91-11263 6G
Delta Floodplain.	Atlanta, Georgia.	Sair Francis Inner of Inner A Walls in
W91-10917 2G	W91-10762 2E	Socio-Economic Impact of Improved Wells in Rural Sierra Leone.
Description Control of the	Unit Hydrographs for Developing Design Flood	W91-11358 6B
Deep-Seated Consolidation Settlements in the Fraser River Delta.	Hydrographs.	***************************************
W91-10948 8D	W91-10809 2E	DEWATERING
W >1-10>40	DESIGN STANDARDS	Application of Electrical Fields to Thicken and Dewater Sewage Sludges.
DEMONSTRATION PROJECTS	Scour at Cantilevered Pipe Outlets, Plunge, Pool	W91-10700 5D
Residential Water Conservation: Casa Del Agua. W91-10814 3D	Energy Dissipator Design Criteria.	
	W91-10722 8B	Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations).
DENDROCHRONOLOGY	First Steps Toward Increasing the Reliability of	W91-10701 5D
Dendrogeomorphic Approach to Measurement of Sedimentation in a Forested Wetland, Black	Hydropower and Water-Management Facilities. W91-11291 8A	
Swamp, Arkansas.	W91-11291 6A	CHP-Filter PressThe First Continuous High- Pressure Filter Press.
W91-11397 2H	DESULFURIZATION	W91-10702 5D
DENIDROCKO LODRILOLOCKI	Treatment of Waste Water From Wet Lime(Stone) Flue Gas Desulfurization Plants	
Dendrogeomorphic Approach to Estimating	With Aid of Crossflow Microfiltration.	Use of a Single-Bowl Continuous-Flow Centri-
Slope Retreat, Maxey Flats, Kentucky.	W91-11371 5D	fuge for Dewatering Suspended Sediments: Effect on Sediment Physical and Chemical
W91-11395 2D	DETECTION LIMITS	Characteristics.
Dendrogeomorphic Approach to Measurement	Rapid Preconcentration Method for Multiele-	W91-11350 7B
of Sedimentation in a Forested Wetland, Black	ment Analysis of Natural Freshwaters. W91-10892 7B	DHIR BEEL (LAKE)
Swamp, Arkansas.		Impact of Physico-chemical Complexes on
W91-11397 2H	Sensitive High-Performance Liquid Chromato-	Plankton Density in Dhir Beel of Assam.
DENITRIFICATION	graphic Analysis for Toxicological Studies with Carbaryl.	W91-11527 2H
Nitrate Removal by Denitrification in Alluvial	W91-10920 5A	DIAGENESIS
Ground Water: Role of a Former Channel. W91-10909 5B	DETERGENTS	Chemical Composition of the Interstitial Water
W 51-10909	Effects of Linear Alkylbenzene Sulphonate	in Bottom Sediments of Tyrrhenian Sea (West-
Denitrification by Thermophilic Soil Bacteria	(LAS) on Skeletal Development of Sea Urchin	ern Mediterranean): Diagenetic Processes. W91-10880 2J
With Ethanol as Substrate in a USB Reactor. W91-11254 5D	Embryos (Paracentrotus lividus LMK). W91-10891 5C	
		Ion Concentrations in Interstitial Water as Indi-
Denitrification in Laboratory Sand Columns:	Ban on Phosphorus in Detergents: The Effects on the Phosphorus Contents of Swiss Sewage	cators for Phosphorus Release Processes and Reactions.
Carbon Regime, Gas Accumulation and Hy- draulic Properties.	Sludges and on the Efficiency of Phosphorus	W91-10888 2K
W91-11330 5G	Elimination by Sewage Treatment Plants.	Reactive Continuum Representation of Organic
Sediment Denitrification Potential in the Eliza-	W91-11142 5D	Matter Diagenesis.
beth River, Virginia.	1-Naphthalenesulfonic acid and Sulfate as Sulfur	W91-11448 2J
W91-11537 5C	Sources for the Green Alga Scenedesmus obli-	DIATOMACEOUS EARTH
DENMARK	quus. W91-11326 5D	Adsorption of Viruses by Diatomaceous Earth
Measures for Purification of the Leachate from		Coated with Metallic Oxides and Metallic Per-
'Renseanlaeg Damhusaen' into Copenhagen	DETERIORATION Predicting Concrete Service Life in Cases of	oxides.
Waters, to Meet the NPO-Plan.	Deterioration Due to Freezing and Thawing.	W91-10659 5A
W91-10601 5D	W91-10734 8F	DIATOMS
DEPOSITION	DETOXIFICATION	Bloom of Coscinodiscus wailesii and DO Deficit
Interannual Variability in Acidic Deposition on	Detoxification by Sephadex LH20 of Seafood	of Bottom Water in Seto Inland Sea.
the Mt. Mitchell Area Forest. W91-10478 5B	Concentrates for Rotavirus Assay.	W91-10549 5C
	W91-10696 5A	Effects of pH and Aluminum on the Growth of
Air Quality and Deposition of Trace Elements in	Treatment and Detoxification of Aqueous	the Acidophilic Diatom Asterionella ralfsii var.
the Province of South-Holland. W91-11248 5B	Spruce Bark Extracts by Aspergillus niger. W91-11481 5D	americana. W91-10862 2H
35		411

Size Structure of Particulate Biogenic Silica in Lake Michigan.	Identification of Dioxin Sources In an Integrated Wood Processing Facility.	Formation of Chlorophenols and Related Com- pounds In Natural and Technical Chlorination
W91-10975 2H	W91-11475 5B	Processes. W91-11508 5B
Assessment of Water Pollution using Diatom Community Structure and Species Distribution A Case Study in a Tropical River Basin. W91-11404 5C	DIRECTORIES Directory of Member Organizations of the National Water Data Exchange (NAWDEX). W91-11574 10D	DISPERSAL Dispersal Dynamics of Groundwater Bacteria. W91-10843 5B
Regulatory Influence of Water Current on Algal Colonization in an Unshaded Stream at Shillong (Meghalaya, India). W91-11451 2E	Directory of Assistance Centers of the National Water Data Exchange (NAWDEX).  W91-11575 10D	DISPERSANTS Using Oil Spill Dispersants on the Sea. W91-10716 5G
W91-11431 2E	DISCHARGE HYDROGRAPHS	DISPERSION
Diatom Analysis, Late-Glacial and Post-Glacial Development of Lake Kleiner Barsch-See (GDR)A Preliminary Note.	Runoff Analysis of the Chang Jiang (The Yangtze River). W91-10966 2E	Outflow and Three-Dimensional Spreading of River Water in Enclosed Bay. W91-10525 2L
W91-11517 2H	DISINFECTION	Circulation and Pollutant Dispersion in Masan-
Mechanisms of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Dia- toms.	Waterborne Disease Outbreak. W91-10615 5C	Jinhae Bay of Korea. W91-10526 5B
W91-11562 5C	Effectivity of Chlorine Dioxide to Control Aer-	Geomorphological Dispersion.
DICHLOROPHENOLS	omonas in Drinking Water Distribution Systems. W91-10677 5F	W91-11232 2E
Oxic Fluidized-Bed Treatment of Dichlorophen-	W91-100//	DISSOLVED AIR FLOTATION Removal of Humic Substances and Algae by
ols. W91-11485 5D	Chlorine Resistance of Motile Aeromonas spp. W91-10678 5F	Dissolved Air Flotation. W91-10751 5F
DIELDRIN	Comparative Inactivation of Hepatitis A Virus	
Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta	and Other Enteroviruses in Water by Iodine. W91-10679 5F	DISSOLVED ORGANIC CARBON Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Poten- tial Regrowth of Bacteria.
Endosulfan.	UV Disinfection: Short Term Inactivation and Revival.	W91-10630 5F
W91-11375 5B	W91-10680 5F	
DIFFUSION Determination of Effective Diffusion Coeffi-	UV Disinfection of Secondary Effluents from	Studies of Dissolved Carbohydrates (or Carbohydrate-Like Substances) in an Estuarine Envi-
cients for Gaseous and Dissolved Organic Sub- stances in Soil Material Using a 'Stopped Elu-	Sewage Treatment Plants. W91-10681 5D	ronment. W91-10840 2L
tion' Method with HPLC and GC. W91-10802 7B	F-Specific RNA Bacteriophages as Model Vi-	DISSOLVED OXYGEN  Diel Oxygen Cycle in Three Subalpine Swiss
Diffusion in Fractal Porous Media.	ruses in UV Disinfection of Wastewater. W91-10682 5D	Streams.
W91-11243 2F		W91-10899 2H
DIFFUSION COEFFICIENT	Activity of Peracetic Acid on Sewage Indicator Bacteria and Viruses.	In-Situ Sediment Oxygen Demand in Five
Determination of Effective Diffusion Coeffi- cients for Gaseous and Dissolved Organic Sub-	W91-10683 5D	Southwestern U.S. Lakes. W91-11333 2H
stances in Soil Material Using a 'Stopped Elu- tion' Method with HPLC and GC.	Disinfection Capability in Water for Swimming and Bathing Pools: A Simple Method for Their	DISSOLVED SOLIDS Bioavailability of Organic Pollutants in Boreal
W91-10802 7B	Evaluation in Practice. W91-10684 5F	Waters with Varying Levels of Dissolved Or- ganic Material.
DIGITAL MAP DATA	Classification of the Company of the	W91-10936 5B
Relationship of MSS and TM Digital Data with Suspended Sediments, Chlorophyll, and Tem- perature in Moon Lake, Mississippi.	Clostridium perfringens, as an Indicator Micro- organism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems.	Identity of Suspended Particles in a Calcite- Depositing Stream and Their Significance in
W91-11354 7C	W91-10686 5D	Trapping and Binding Phenomena. W91-11522 2E
DIKES Flow Control Technology for Enhancement and	Salmonella Detection in Sewage Waters Using Fluorescent Antibodies.	DISTRIBUTION
Diverse Use of the Marine Environment. W91-10607 2L	W91-10687 5D	Macroinvertebrate Responses along a Complex
W91-1000/	Destruction of Faecal Bacteria, Enteroviruses	Regulated Stream Environmental Gradient. W91-10848 4A
DIMETHOXYPROPANE Use of 2,2-Dimethoxypropane for the Direct	and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophi-	DISTRIBUTION PATTERNS
Gas Chromatographic-Mass Spectrometric De- termination of Some Organic Compounds in	lic Digestion. W91-10688 5D	Zonal Average Cloud Characteristics for Global Atmospheric Chemistry Modelling.
Water.	Algicidal and Chemical Effect of u.vRadiation	W91-10728 2B
W91-11245 5A	of Water Containing Humic Substances.	Aquatic Macroinvertebrates of the St. Francis
DINITRO-O-CRESOL	W91-10941 5F	Sunken Lands in Northeast Arkansas.
Induction of Biotransformation in the Liver of Eel (Anguilla anguilla L.) by Sublethal Exposure	Improvement of the Quality of Sewage Sludge:	W91-10844 4C
to Dinitro-o-cresol: An Ultrastructural and Bio- chemical Study.	Microbiological Aspects. W91-11125 5D	Downstream Changes in Caddisfly Composition and Abundance in Relation to Changes in Water
W91-10826 5C		Conductivity and Oxygen in the River Butron
DIOXINS	Stabilization of Sewage Sludge and Its Disinfec- tion According to Specific Requirements: Two-	Basin. W91-11403 5C
Dioxins  Dioxin Contamination and Growth and Devel-	Stage Anaerobic/Aerobic Operating Tech-	
opment in Great Blue Heron Embryos.	niques.	DIURNAL VARIATION
W91-10837 5C	W91-11141 5D	Ecophysiological Significance of the Diel Bio- chemical Changes of Particulates Coupled with
Major Incident of Dioxin Contamination: Sedi-	Aerobic-Thermophilic Methods for Disinfecting	Metabolic and Environmental Parameters in
ments of New Jersey Estuaries. W91-11341 5B	and Stabilizing Sludge. W91-11143 5D	Two Trophically Different Lakes. W91-10896 2H

## DIURNAL VARIATION

Diel Oxygen Cycle in Three Subalpine Swiss Streams. W91-10899 2H	DRAINAGE EFFECTS Model of Ammonia Volatilization From Applied Urea. V. The Effects of Steady-State Drainage	Health Risk Assessment of Water Contaminants Using Baseline Data of Cancer Incidence in Dif- ferent Water Supply Areas.
	and Evaporation.	W91-10614 5F
DIVERSION Geomorphic, Geographic, and Hydrographic	W91-10805 3F	Waterborne Disease Outbreak.
Basis for Resolving the Mono Lake Controver-	DRAINAGE ENGINEERING	W91-10615 5C
sy. W91-11442 6G	Solution in Closed Form and a Series Solution to Replace the Tables for the Thickness of the	Prospective Epidemiological Study of Drinking Water Related Gastrointestinal Illnesses.
DIVERSION STRUCTURES	Equivalent Layer in Hooghoudt's Drain Spacing Formula.	W91-10618 5B
Managing Transboundary Water Diversions: Experience From a Private Utility.	W91-11430 2G	Need for New Microbiological Water Quality
W91-11045 6A	DRAINAGE PATTERNS	Criteria.
DNA	Comparison of Nocturnal Drainage Flow in Three Tributaries.	W91-10621 5F
Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water.  W91-10667 5A	W91-10501 2E	Evaluation of Fecal Enterococci Isolation Media to Indicate Fecal Pollution in Chlorinated
	DRAINAGE SYSTEMS  Behavior of Double Geonet Drainage Systems.	Water. W91-10626 5F
PCR and Environmental Monitoring: The Way Forward.	W91-11096 5A	Coliform Bacteria in Drinking Water from
W91-10670 5A	DRAINAGE WATER	South Bavaria: Identification by the API 20E-
DNEPR RIVER	Production Functions Relating Crop Yield,	System and Resistance Patterns. W91-10627 5F
Operating Experience and Suggestions on Re-	Water Quality and Quantity, Soil Salintiy and Drainage Volume.	W91-10027
construction of the Turbines of the Dnepr-I Hy- droelectric Station.	W91-11434 3C	Effect of Heat Shock on Recovery of Escheri- chia coli from Drinking Water.
W91-11290 8C	DRASTIC SYSTEM	W91-10628 5F
DOKAI BAY	Application of the DRASTIC Mapping System for Evaluating Ground Water Pollution Poten-	Bacteriological Suitability of Water from Basrah
Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.	tial in Ohio.	Wells for Drinking. W91-10629 5A
W91-10550 5G	W91-11178 5B	
DOMESTIC WASTES	DRAWDOWN	Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Poten-
Management of the Marine Environment in Western Australia: An Ecosystem Approach.	Geohydrologic Evaluation of Spring Sites at Social Circle, Georgia, December 5-8, 1988.	tial Regrowth of Bacteria. W91-10630 5F
W91-10583 5G	W91-10767 2F	Providence Chiefe Divide to Control Ass
DOMESTIC WATER Water Use Reductions from Retrofitting Indoor Water Fixtures.	Evaluation of Analytical Solutions to Estimate Drawdowns and Stream Depletions by Wells. W91-11240 2F	Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677 5F
W91-10811 6D	DREDGING	Health Risk Assessment of Toluene in California
Residential Water Conservation: Casa Del Agua. W91-10814 3D	Lake Lansing Dredging Evaluation Study, 1978- 1984.	Drinking Water. W91-10741 5C
Incidence of Legionella in the Urban Environ-	W91-10748 5G	Drinking Water Criteria Document on Xylene.
ment in Australia.	Hydraulicking in Environmental Protection and	W91-10757 5C
W91-10929 5B	Restoration. W91-11283 5G	Development of an Enzyme-Linked Immunosor- bent Assay for Geosmin.
DRAG		W91-10921 5F
Drag on Vertical Sill of Forced Jump. W91-10985 8B	Intake Devices for Dredges with Submersible Suction Pumps.	Analysis of Halogenated Acetic Acids in Dutch
DRAIN SPACING	W91-11287 8C	Drinking Water.
Solution in Closed Form and a Series Solution to	DREDGING EFFECTS	W91-10938 5F
Replace the Tables for the Thickness of the Equivalent Layer in Hooghoudt's Drain Spacing	Confirmatory Chemical Analyses and Solid Phase Bioassays on Sediment from the Columbia	Willingness-to-Pay for Protection of Water Sup- plies in Four Massachusetts' Towns.
Formula. W91-11430 2G	River Estuary at Tongue Point, Oregon. W91-10753 5B	W91-11056 6C
DRAINAGE	DREDGING WASTES	Comparative Physico-Chemical Analysis of
Ground-Water Flow and Solute Movement to	Application of a Hazard Assessment Research	Drinking, Ground and Industrial Waste Water of Jodhpur.
Drain Laterals, Western San Joaquin Valley, California. II. Quantitative Hydrologic Assess-	Strategy to the Ocean Disposal of a Dredged Material: Overview.	W91-11083 5B
ment. W91-10769 5B	W91-10740 5E	Pesticides and Drinking Water Information: A Perspective from EPA's National Pesticide
Hydrological Consequences of Artificial Drain-	Confirmatory Chemical Analyses and Solid Phase Bioassays on Sediment from the Columbia	Survey. W91-11173 5D
age of Grassland. W91-11347 2G	River Estuary at Tongue Point, Oregon. W91-10753 5B	Maryland's Train-The-Trainer Program House-
Periodic Drainage of Ice-Dammed Lakes as a	Evaporative Drying of Dredged Material.	hold Hazardous Waste. W91-11200 5G
Result of Variations in Glacier Velocity.	W91-11000 5D	
W91-11348 2C	DRINKING WATER	Water and Human Health. W91-11211 5F
Studies of Springs in the Southern Part of the Valley of Mexico (Estudio Crenologico en la	Special Report: Water Supply and Sanitation. W91-10482 5F	Capillary Column Gas Chromatography With
Parte Meridional de la Cuenca de Mexico). W91-11352 2E	Health-Related Water Microbiology 1990.	Nitrogen-Phosphorus Detection for Determina- tion of Nitrogen-and Phosphorus-Containing
DRAINAGE AREA	W91-10612 5F	Pesticides in Finished Drinking Waters: Collabo-
Seasonal Changes in the Sanitary Bacterial Qual- ity of Water Draining a Small Upland Catch-	Microbiological Methods for Safety Testing of Drinking Water Directly Reclaimed from	rative Study. W91-11259 5A
ment in the Yorkshire Dales.	Wastewater.	Direct Aqueous Injection-Liquid Chromatogra-
W91-10935 5B	W91-10613 5A	phy With Post-Column Derivatization for De-

termination of N-Methylcarbamoyloximes and N-Methylcarbamates in Finished Drinking	DYES Characteristics of Rhodamine WT and Fluores-	Microzoobenthos of the River Jihlava After the Construction of the Dalesice Waterworks.
Water: Collaborative Study. W91-11260 5A	cein as Adsorbing Ground-Water Tracers. W91-10952 5B	W91-11521 6G
Determination of Nitroaromatics and Nitramines	1-Naphthalenesulfonic acid and Sulfate as Sulfur Sources for the Green Alga Scenedesmus obli-	Can Fauna Impoverishment Affect Humus Con- tent in Cultivated Soils (Czy ubozenie fauny
in Ground and Drinking Water by Wide-Bore Capillary Gas Chromatography.	quus.	moze wplywac na zawartosc prochnicy w gle- bach uprawnych).
W91-11262 5A	W91-11326 5D	W91-11543 2G
Cryptosporidiosis and Water Supply: A Brief Review, with Special Reference to the Report of	EARTH DAMS Method of Calculating the Technological Pa-	Estimation of Sport Fish Harvest for Risk and Hazard Assessment of Environmental Contami-
the Badenoch Committee. W91-11271 5F	rameters When Designing Hydraulic-Fill Dams of Silty Soils.	nants.
	W91-11284 8A	
Situation of Water Supply in the New Lander of the Federal Republic of Germany.	EARTH-WATER INTERFACES	ECONOMIC ASPECTS Improved Policy Instruments for Management
W91-11272 5F	Hydrologic Science: A Distinct Geoscience. W91-11429 2A	of Enclosed Coastal Seas and Estuaries: The
Analysis of 10 Selected Herbicides in Water.	EARTHQUAKE ENGINEERING	Chesapeake Bay, USA. W91-10610 2L
W91-11311 5A	Seismic Hazard at Narmada Sagar Dam. W91-10949 8E	Political Economic Model of International Pol-
Strategy for Pesticide Control in Ground Water		lution.
and Drinking Water. W91-11312 5A	EARTHQUAKES Nonlinear Earthquake Response of Concrete	W91-11016 5B
	Gravity Dam Systems.	Socio-Economic Considerations in Remedial
New Standards for the Determination of Geos- min and Methylisoborneol in Water by Gas	W91-10754 8F	Action Planning for the Great LakesA Case Study for Sustainable Development.
Chromatography/Mass Spectroscopy. W91-11329 5A	EAST CHINA SEA East Asian Seas: Hypothetical Oil Spill Trajec-	W91-11031 6A
Measuring Low Radon Levels in Drinking	tories. W91-10608 5B	Watershed-Based Conservation Programs is the
Water Supplies.		Public Getting Its Money's Worth. W91-11044 6C
W91-11463 5A	ECHINODERMS Marine Pollution Bioassay by Using Sea Urchin	
DROUGHT	Eggs in the Tanabe Bay, Wakayama Prefecture,	Preliminary Data Summary for Industrial Laun- dries.
Hydrological Aspects of the 1988 Drought in Illinois.	Japan, 1970-1987. W91-10602 5A	W91-11093 5B
W91-10810 2B	Impact of Titanium Dioxide Waste on Fertiliza-	Funding New York State's Integrated Pest Man-
Regional Approach to Drought Planning and	tion in the Sea Urchin Echinometra mathaei. W91-10870 5C	agement Program. W91-11180 6C
Management in the Great Lakes Basin. W91-11012 6A		
Spring and Summer 1988 Drought over the	Effects of Linear Alkylbenzene Sulphonate (LAS) on Skeletal Development of Sea Urchin Embryos (Paracentrotus lividus LMK).	Water Management in the 21st Century. W91-11206 4A
Contiguous United StatesCauses and Predic- tion.	W91-10891 5C	Aquatic Habitat Measurement and Valuation:
W91-11412 2B	ECOLOGICAL DISTRIBUTION	Imputing Social Benefits to Instream Flow Levels.
DROUGHT EFFECTS	Regulatory Influence of Water Current on Algal Colonization in an Unshaded Stream at Shillong	W91-11266 7C
Microclimatological Investigations in the Tropi- cal Alpine Scrub of Maui, Hawaii: Evidence for	(Meghalaya, India). W91-11451 2E	Economic Analysis of Off-Farm Soil Conserva- tion Structures.
a Drought-Induced Alpine Timberline. W91-10878 2I	Habitat Use by an Assemblage of Fish in a Large	W91-11567 4D
	Warmwater Stream.	Preliminary Data Summary for the Machinery
Effects of Drought Stress and Simulated Acidic Rain on Foliar Conductance of Zea mays L.	W91-11533 2H	Manufacturing and Rebuilding Industry.
W91-10919 5C	Distribution, Habitat Use, and Growth of Age-0 Colorado Squawfish in the Green River Basin,	W91-11589 5B
Effects of the 1988 Drought on Water Resources	Colorado and Utah.	ECONOMIC DEVELOPMENT Toward Environmental Planning for East Asian
in Wisconsin. W91-11108 2E	W91-11534 2H	Estuaries: Japanese and Chinese Enclosed Bays.
	ECOLOGICAL EFFECTS	W91-10565 2L
Dry Deposition Washoff from Forest Tree	Change of Oceanic Condition by the Man-Made Structure for Upwelling.	Ecological Assessment of Semi-Enclosed Marine
Leaves by Experimental Acid Rainfall.	W91-10542 8I	Water Bodies of the Archipelago Sabana-Cama- guey (Cuba) Prior to Tourism Development
W91-10476 5B	Lake Lansing Dredging Evaluation Study, 1978-	Projects.
DUCKS Subchronic Hepatotoxicity of Selenomethionine	1984. W91-10748 5G	W91-10566 6G
Ingestion in Mallard Ducks.	Review of Interbasin Water Transfers with Spe-	Study on Model Reference Adaptive Water Pol- lution Control in Enclosed Coastal Sea.
W91-10838 5C	cific Attention to Biota. W91-11013 6B	W91-10567 5G
DYE INDUSTRY WASTES  Colour Removal from Textile Effluents by Ad-		Aral Sea Basin: A Critical Environmental Zone.
sorption Techniques.	Removal of Biota from Inter-Basin Transfer Water.	W91-11441 6G
W91-11323 5D	W91-11017 5F	ECOSYSTEMS
Activated Sludge Process to Reduce the Pollu-	Management of Irrigation-Induced Contami-	Organization of the Dynamic Network Struc- ture in the Dimension of Time.
tion Load of a Dye-Industry Waste. W91-11455 5D	nants. W91-11063 5G	W91-10492 2H
DYE RELEASES	Impact of a Pulse Application of Permethrin on	Seagrass-Mangrove Ecosystems Management: A
Characteristics of Rhodamine WT and Fluores-	the Macroinvertebrate Community of a Head-	Key to Marine Coastal Conservation in the
cein as Adsorbing Ground-Water Tracers.	water Stream. W91-11456 5C	ASEAN Region. W91-10539 5G
W91-10952 5B	W91-11456 5C	W 71-10339

## **ECOSYSTEMS**

Long Term Ecological Changes in the Gulf of Thailand. W91-10551 5B	Towards Management of Environmental Prob- lems in Egypt. W91-11373 6G	ELECTROPHORESIS Pulsed Field Electrophoresis of Genomic Restriction Fragments for the Detection of Noso-
Ecological Modelling at Osaka Bay Related to	EL NINO/SOUTHERN OSCILLATION Relation of Atmospheric CO2 to Tropical Sea	comial Legionella pneumophila in Hospital Water Supplies.
Long-Term Eutrophication. W91-10556 5C	and Air Temperatures and Precipitation.	W91-10836 5A
Primary Productivity and Plankton Communi-	W91-11002 2B	ELIZABETH RIVER
ties in a Two-Reservoir Series.	ELBE RIVER	Sediment Denitrification Potential in the Eliza- beth River, Virginia.
W91-10815 2H	Virological Investigation of the River Elbe. W91-10652 5B	W91-11537 5C
Breaking the Incrementalist Trap: Achieving	ELECTRIC CONVERTERS	ELLIOTT LAKE
Unified Management of the Great Lakes Ecosys- tem.	Converter Application for Mini Hydro Genera-	226-Ra and Other Radionuclides in Water, Vegetation, and Tissues of Beavers (Castor cana-
W91-11025 6A	tion. W91-11213 8C	densis) from a Watershed Containing U Tailings
Energy Transformation-Ecology Interface from	ELECTRIC CURRENTS	Near Elliot Lake, Canada. W91-11454 5B
a Nonlinear, Nonequilibrium Thermodynamic Perspective.	Application of Electrical Fields to Thicken and	
W91-11085 5B	Dewater Sewage Sludges. W91-10700 5D	EMBANKMENTS  Analysis of a Sanitary-Embankment Failure
ECOTOXICOLOGY	ELECTRIC FIELDS	Over the Rio de Janeiro Soft Clay Deposit.
Ambient Water Quality Criteria for Ammonia	Electrical and Kinematic Structure of the Strati-	W91-10780 8D
(Saltwater)-1989. W91-10750 5G	form Precipitation Region Trailing an Oklahoma	Comparison of Field Consolidation with Labora-
	Squall Line. W91-10514 2B	tory and In Situ Tests. W91-10781 8D
EDUCATION  Professionalism in Agriculture: Seeking a Train-	ELECTRIC POWER PRODUCTION	
ing Standard.	Stability of Hydropower Construction Pro-	EMERALD LAKE  Executive Summary-Assessing the Response of
W91-11198 5G	grams. W91-11294 8C	Emerald Lake, An Alpine Watershed in Sequoia
Developing a Groundwater Training Program	ELECTRICAL EQUIPMENT	National Park, California, to Acidification During Snowmelt Using a Simple Hydrochemi-
for Pesticide Users. W91-11199 5G	Converter Application for Mini Hydro Genera-	cal Model.
Maryland's Train-The-Trainer Program House-	tion. W91-11213 8C	W91-11112 7C
hold Hazardous Waste.		Assessing the Response of Emerald Lake, an Alpine Watershed in Sequoia National Park,
W91-11200 5G	Experience with Low-Head HydroPlant Fre- quency Control.	California, to Acidification during Snowmelt by
Farm Bureau's Groundwater and Environmental	W91-11214 8C	Using a Simple Hydrochemical Model.
Quality Self-Help Checklist for Farmsteads and Farm Fields.	ELECTRICAL SURVEYS	W91-11594 5C
W91-11201 5G	Delineation of a Discontinuous Aquitard with Vertical Electrical Soundings, San Bernardino	EMISSION SPECTROMETRY Rapid Preconcentration Method for Multiele-
Florida's Pesticide Water Quality Education Program.	Valley, Southern California. W91-10960 5B	ment Analysis of Natural Freshwaters. W91-10892 7B
W91-11202 5G	ELECTRO-OSMOSIS	EMISSIONS CONTROL
Dynamics of Water Policy.	Electroosmotic Strengthening of Soft Sensitive	Environmental Control Impacts of Selected Al-
W91-11212 6E	Clays. W91-10777 8D	ternate Fuels on Existing Power Plants.
EEL		W91-11078 5G
Induction of Biotransformation in the Liver of	Field Test of Electroosmotic Strengthening of Soft Sensitive Clay.	Mathematical Modelling for Sulphur Dioxide Removal from Stack Gases in a Fluidized Bed of
Eel (Anguilla anguilla L.) by Sublethal Exposure to Dinitro-o-cresol: An Ultrastructural and Bio-	W91-10778 8D	Activated Sodium Carbonate.
chemical Study.	ELECTROCHEMISTRY	W91-11080 5G
W91-10826 5C	Application of Electrical Fields to Thicken and	ENCLOSED SEAS
EFFLUENT LIMITATIONS Toxicity Reduction Evaluations (TRE's) As a	Dewater Sewage Sludges. W91-10700 5D	Modern Environmental Assessment Procedures for Enclosed Seas.
Tool for Meeting Effluent Standards.	Comparison of Amperometric and UV-Spectro-	W91-10564 6G
W91-11542 6E	photometric Monitoring in the HPLC Analysis	Countermeasures Against Water Pollution in
EFFLUENTS	of Pesticides. W91-11306 5A	Enclosed Coastal Seas in Japan.
Quality of Salmonid Hatchery Effluents During a Summer Low-Flow Season.		W91-10572 5G
w91-11532 5D	Liquid Effluents: New Solutions to Old Prob- lems.	ENDANGERED SPECIES
EGYPT	W91-11360 5D	Pacific Salmon at the Crossroads: Stocks at Risk from California, Oregon, Idaho, and Washing-
Incidence and Ecology of Marine Fouling Orga-	ELECTRODIALYSIS	ton.
nisms in the Eastern Harbour of Alexandria, Egypt.	Investigations With Electrodialysis Reversal for the Treatment of Surface Water to Make-Up	W91-10834
W91-10560 5C	Water.	Sensitivity of Greenback Cutthroat Trout to
Egyptian Approach Towards Appropriate Use	W91-11368 5F	Acidic pH and Elevated Aluminum. W91-11531 5C
of Coastal Zones on the Red Sea.	ELECTROLYSIS  Electrolytic Model System for Reductive Deha-	ENDOSULFAN
W91-10561 6G	logenation in Aqueous Environments.	Simple Spectrophotometric Determination of
Need for New Microbiological Water Quality	W91-11343 5B	Endosulfan in River Water and Soil.
Criteria. W91-10621 5F	ELECTRONIC EQUIPMENT	W91-11314 5A
Patella vulgata, Mytilus minimus and Hyale pre-	Use of Electronic Data-Logging Equipment to Monitor Hydrologic Parameters in a Humid	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis,
vosti as Bioindicators for Pb and Se Enrichment	Cave Environment in Wind Cave National Park,	and Photolysis of Dieldrin and Alpha and Beta
in Alexandria Coastal Waters. W91-10875 5A	South Dakota. W91-11389 7B	Endosulfan. W91-11375 SE
177-10013 JA	11 /1-11307 /D	W91-11375 5E

ENERGY	Survival of Pathogenic Bacteria in an Adverse	Effects of Land-Use Buffer Size on Spearman's
Scour at Cantilevered Pipe Outlets, Plunge, Pool	Environment.	Partial Correlations of Land Use and Shallow
Energy Dissipator Design Criteria.	W91-10692 5D	Ground-Water Quality.
W91-10722 8B	ENTEROBACTER	W91-10761 4C
ENERGY DISSIPATION	Species and Genera of Enterobacteriaceae in	Land Use, Water Use, Streamflow Characteris-
Drag on Vertical Sill of Forced Jump.	River Neckar and After River Bank Filtration	tics, and Water-Quality Characteristics of the
W91-10985 8B	and Their Resistance Patterns to Antibiotics and	Charlotte Harbor Inflow Area, Florida.
ENERGY SOURCES	Heavy Metal Salts. W91-10675 5B	W91-10771 4C
Uncertainty in the Projection of Carbon Dioxide	W91-100/3	Ecophysiological Significance of the Diel Bio-
Emissions.	ENTEROVIRUSES	chemical Changes of Particulates Coupled with
W91-11069 5B	Recovery of Enterovirus from Primary Sludge	Metabolic and Environmental Parameters in
Environmental Control Impacts of Selected Al-	Using Three Elution Concentration Procedures. W91-10657 5A	Two Trophically Different Lakes.
ternate Fuels on Existing Power Plants.		W91-10896 2H
W91-11078 5G	Detection of Hepatitis A Virus and Other Enter-	Interstate Cooperation in Dealing with Growth
ENERGY TRANSFER	oviruses in Wastewater and Surface Water Sam- ples by Gene Probe Assay.	Related Water Quality Impacts on the Chesa-
Organization of the Dynamic Network Struc-	W91-10665 5A	peake Bay.
ture in the Dimension of Time.		W91-11009 6E
W91-10492 2H	Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water.	Effects of Changes in Land Use on Annual
Energy Transformation-Ecology Interface from	W91-10667 5A	Streamflows in the Lake Huron Basin of Canada
a Nonlinear, Nonequilibrium Thermodynamic	W71-1000	and the United States.
Perspective.	Comparative Inactivation of Hepatitis A Virus	W91-11021 4C
W91-11085 5B	and Other Enteroviruses in Water by Iodine. W91-10679 5F	Great Lakes Levels and Flows Under Natural
ENGINEERING GEOLOGY	W91-100/9	and Current Conditions.
Engineering Geology of Nearshore Areas off	Destruction of Faecal Bacteria, Enteroviruses	W91-11022 2H
Richards Island, N.W.T.: A Comparison of	and Ova of Parasites in Wastewater Sludge by	Energy Transformation-Ecology Interface from
Stable and Actively Eroding Coastlines. W91-10944 2J	Aerobic Thermophilic and Anaerobic Mesophi- lic Digestion.	a Nonlinear, Nonequilibrium Thermodynamic
W91-10944 23	W91-10688 5D	Perspective.
ENGLAND		W91-11085 5B
Thames Water's Experiences with Cryptospori-	Comparison of Methods for the Isolation of a	Environmental Aspects of Sludge Incineration:
dium. W91-10617 5C	Wide Range of Viruses from Shellfish. W91-10698 5A	Overview.
W91-10017	W 91-10098	W91-11130 5E
Destruction of Faecal Bacteria, Enteroviruses	Bacteriophages as Model Viruses in Water Qual-	
and Ova of Parasites in Wastewater Sludge by	ity Control.	Dams and Sustainable Development in Brazilian
Aerobic Thermophilic and Anaerobic Mesophi- lic Digestion.	W91-10883 5G	Amazonia. W91-11216 8C
W91-10688 5D	Laboratory Studies of Virus Survival During	W 21-11210
	Aerobic and Anaerobic Digestion of Sewage	Urbanization and Urban Water Problems in
Seasonal Changes in the Sanitary Bacterial Qual- ity of Water Draining a Small Upland Catch-	Sludge. W91-11319 5D	Southeast Asia: A Case of Unsustainable Devel-
ment in the Yorkshire Dales.	W91-11319 3D	opment. W91-11263 6G
W91-10935 5B	Coliphage and Bacteriophage as Indicators of	W71-11203
	Recreational Water Quality.	Avalon Lakes: An Environmental Opportunity.
Precipitation in Britain: An Analysis of Area- Average Data Updated to 1989.	W91-11334 5A	W91-11362 6G
W91-10973 2B	ENVIRONMENTAL CHEMISTRY	Agronomic Effects of Land Application of
	Budgets of Selected Cations and Anions in Two	Water Treatment Sludges.
Cryptosporidiosis and Water Supply: A Brief	Forested Experimental Watersheds in Central	W91-11459 4C
Review, with Special Reference to the Report of the Badenoch Committee.	Greece. W91-11550 4C	Eutrophication of Pulp and Paper Wastewater
W91-11271 5F	W91-11330 4E	Recipients.
	ENVIRONMENTAL EFFECTS	W91-11509 5C
Avalon Lakes: An Environmental Opportunity.	Estimating the Effects on the Regional Precipi-	
W91-11362 6G	tation Climate in a Semiarid Region Caused by an Artificial Lake Using a Mesoscale Model.	ENVIRONMENTAL GRADIENT
Channel Tunnel and Its Impact on the Folkes-	W91-10502 2B	Spatial Distribution of Rainfall in the Greater Athens Area.
tone and District Water Company.		W91-11416 2B
W91-11363 4C	New Dead Sea. W91-10504 5C	
Fenay Beck Flood-Alleviation Scheme.	W 71-10304	ENVIRONMENTAL IMPACT
W91-11365 8A	Long Term Ecological Changes in the Gulf of	Kansai International Airport Project and Envi- ronmental Impact Assessment.
Results of the First Pilot-Scale Controlled	Thailand. W91-10551 5B	W91-10563 4C
Cohort Epidemiological Investigation into the	W91-10331 3B	
Possible Health Effects of Bathing in Seawater	Impact of Coastal Development on the Infralit-	Modern Environmental Assessment Procedures for Enclosed Seas.
at Langland Bay, Swansea.	toral Zone Along the Southeastern Mediterrane-	W91-10564 6G
W91-11366 5C	an Shore of Continental France. W91-10562 6G	
Four-Parameter Model for the Estimation of	W 91-10302	Toward Environmental Planning for East Asian
Rainfall Frequency in South-West England.	Kansai International Airport Project and Envi-	Estuaries: Japanese and Chinese Enclosed Bays.
W91-11415 2B	ronmental Impact Assessment.	W91-10565 2L
ENRICHMENT	W91-10563 4C	Ecological Assessment of Semi-Enclosed Marine
Impact of Nutrient Enrichment and Their Rela-	Development of Risk Assessment Methodology	Water Bodies of the Archipelago Sabana-Cama-
tion to the Algal Bloom in the Adriatic Sea.	for Land Application and Distribution and Mar-	guey (Cuba) Prior to Tourism Development
W91-10544 5C	keting of Municipal Sludge. W91-10708 5E	Projects. W91-10566 6G
ENTERIC BACTERIA	W 21-10/06	
Miniaturized Fluorogenic Assays for Enumera-	Assessment of the Salinity Tolerance of Eight	Environmental Assessment of Wastewater
tion of E. coli and Enterococci in Marine Water.	Sonoran Desert Riparian Trees and Shrubs.	Marine Disposal of Xiaogang Zone, Ningbo W91-10570 5E
W91-10639 5A	W91-10752 3C	# 71-103/0 JE

### **ENVIRONMENTAL IMPACT**

Assessment of the Environmental Capacity of	ENVIRONMENTAL LAW	National Estuary Program and Public Involve-
Enclosed Coastal Sea. W91-10571 5E	Environmental Research, Policy and Regula- tion: The Chesapeake Bay Experience.	ment. W91-10590 5G
Environmental Research, Policy and Regula-	W91-10575 5G	Legal System and Management of Southern
tion: The Chesapeake Bay Experience. W91-10575 5G	Legislative Implementation of Integrated Catchment Management in Western Australia.	France Lagoons. W91-10611 5G
Environmental Management of the Puget	W91-11374 6E	Interstate Cooperation in Dealing with Growth
Sound.	ENVIRONMENTAL MONITORING Modern Environmental Assessment Procedures	Related Water Quality Impacts on the Chesa- peake Bay.
W91-10577 5G	for Enclosed Seas.	W91-11009 6E
Conceptual Framework of Environmental Man-	W91-10564 6G	Challenge of Implementing Ecosystem Manage-
agement Strategies for Yugoslavia: The Case of the Adriatic Sea. W91-10584 5G	International Programme for the Protection of a Semi-Enclosed Sea: The Mediterranean Action	ment Plans in the Great Lakes Basin. W91-11011 6B
	Plan.	Provincial Guidelines to Great Lakes Shoreline
'Parque de Donana', and Its Contribution to Environmental Activities for Environmental	W91-10574 5G  Environmental Information Processing of	Management Plans. W91-11024 6E
Protection.	Environmental Information Processing of Closed Bay Area by Remote Sensing.	
W91-10586 5G	W91-10581 7B	Social and Private Returns from Wetland Pres-
Environmental Feasibility of Using Wetlands to	Conceptual Framework of Environmental Man-	ervation. W91-11057 5G
Treat Runoff Pollution.	agement Strategies for Yugoslavia: The Case of	
W91-10737 5D	the Adriatic Sea.	Environmental Control Impacts of Selected Al-
Application of a Hazard Assessment Research	W91-10584 5G	ternate Fuels on Existing Power Plants. W91-11078 5G
Strategy to the Ocean Disposal of a Dredged	Environmental Activism in the San Francisco	W91-110/6
Material: Overview.	Bay Estuary.	Oil Transport Management and Marine Pollu-
W91-10740 5E	W91-10585 5G	tion Control: Oil Spill Prevention. W91-11081 5G
Confirmatory Chemical Analyses and Solid Phase Bioassays on Sediment from the Columbia	Nongovernmental Educational Activities for	Future Water Management Problems: The Fed-
River Estuary at Tongue Point, Oregon.	Environmental Protection. W91-10588 5G	eral Role In Their Solution.
W91-10753 5B	W91-10388	W91-11210 4A
	Ambient Air Co-Modeling in Alaska.	Home Koner Con the Donner Class its Nort
Review of Interbasin Water Transfers with Specific Attention to Biota.	W91-11070 7C	Hong Kong: Can the Dragon Clean its Nest. W91-11439 5G
W91-11013 6B	ENVIRONMENTAL POLICY Seagrass-Mangrove Ecosystems Management: A	Environmentally Desirable Approaches for Reg-
Road Salting Impacts in Massachusetts. W91-11053 4C	Key to Marine Coastal Conservation in the ASEAN Region.	ulating Effluents from Pulp Mills. W91-11504 5G
W91-11053 4C	W91-10539 5G	
Studies on Assessment of Water Balance and Its		ENVIRONMENTAL QUALITY
Quality in Gurpur River Basin, Karnataka State, India.	Environmental Research, Policy and Regula- tion: The Chesapeake Bay Experience.	Hong Kong: Can the Dragon Clean its Nest. W91-11439 5G
W91-11065 5B	W91-10575 5G	ENVIRONMENTAL TRACERS
Preliminary Data Summary for Industrial Laun-	Nongovernmental Educational Activities for Environmental Protection.	Environmental Isotope Study for Estimating Leakage and Runoff of Ground Waters in the
dries. W91-11093 5B	W91-10588 5G	Xi'an Area.
W31-11033		W91-10994 2F
Water Management in the 21st Century. W91-11206 4A	Improved Policy Instruments for Management of Enclosed Coastal Seas and Estuaries: The Chesapeake Bay, USA.	New Approach to Tracer Transport Analysis: From Fracture Systems to Strongly Heterogene-
Dams and Sustainable Development in Brazilian	W91-10610 2L	ous Porous Media.
Amazonia.		W91-11554 2F
W91-11216 8C	National Program for Soil and Water Conserva- tion. Its Effect on USDA Services.	ENZYMES
Socio-Political Aspects of the Bos-Nagymaros	W91-11169 3F	Development of an Enzyme-Linked Immunosor-
Barrage System.		bent Assay for Geosmin.
W91-11217 6G	Towards Management of Environmental Prob- lems in Egypt.	W91-10921 5F
Waste Disposal Facilities and Community Re-	W91-11373 6G	Effects of Sewage Sludge and Waste Compost
sponse: Tracing Pathways from Facility Impacts		on Some Soil Enzymatic Activities Tested in a
to Community Attitude.	Hong Kong: Can the Dragon Clean its Nest. W91-11439 5G	Field Experiment. W91-11151 5E
W91-11280 5E		
Distribution and Migration of Heavy Metals in	Radioactivity in Water Treatment Wastes: A	Development of an Enzyme Immunoassay for
the Environment of the Altai Mountains in Connection with Ecological Substantiation of the	W91-11461 5B	the Determination of Metazachlor. W91-11295 5A
Katun Hydroelectric Station Project.	Environmentally Desirable Approaches for Reg-	Biological Bleaching of Wood Pulps-A Viable
W91-11292 5B	ulating Effluents from Pulp Mills.	Chlorine-Free Bleaching Technology.
Effect of Coal-Mine Effluent on Fungal Assem-	W91-11504 5G	W91-11476 5G
blages and Leaf Breakdown.	ENVIRONMENTAL PROTECTION	EPHEMERAL STREAMS
W91-11320 5C		Influence of Leaf Leachate-Enriched Water of
Budgets of Selected Cations and Anions in Two	Estuaries: Japanese and Chinese Enclosed Bays. W91-10565 2L	Neem (Azadirachta indica A. Juss.) and Shirish (Albizzia lebbek Benth.) on the Growth of Eich-
Forested Experimental Watersheds in Central		hornia crassipes (Mart.) Solms.
Greece.	Ecological Assessment of Semi-Enclosed Marine	W91-11449 2I
W91-11550 4C		EPIDEMIOLOGY
Strategic Issues in Watershed Development.	guey (Cuba) Prior to Tourism Development Projects.	Health-Related Water Microbiology 1990.
W91-11564 4D	•	W91-10612 5F

Health Risk Assessment of Water Contaminants	Investigation of Local Scour in Cohesionless	ESTUARIES
Using Baseline Data of Cancer Incidence in Dif- ferent Water Supply Areas.	Sediments Using a Tunnel-Model. W91-10746 2J	Macroalgal-Sediment Nutrient Interactions and Their Importance to Macroalgal Nutrition in a
W91-10614 5F		Eutrophic Estuary.
Waterborne Disease Outbreak.	Spatial and Temporal Influence of Soil Frost on Infiltration and Erosion of Sagebrush Range-	W91-10497 2L
W91-10615 5C	lands.	First-Order Organic Carbon Budget in the St
Causes of Waterborne Outbreaks in the United	W91-10820 2G	Lawrence Lower Estuary from 13C Data. W91-10498 2L
States. W91-10616 5B	Engineering Geology of Nearshore Areas off	Managing Oregon's Estuarine Resources Lands.
	Richards Island, N.W.T.: A Comparison of Stable and Actively Eroding Coastlines.	W91-10508 2L
Thames Water's Experiences with Cryptospori- dium.	W91-10944 2J	Toward Environmental Blancins for East Asian
W91-10617 5C	Sentember 5 1097 Lendelide on the Le Crende	Toward Environmental Planning for East Asian Estuaries: Japanese and Chinese Enclosed Bays.
Prospective Epidemiological Study of Drinking	September 5, 1987, Landslide on the La Grande River, James Bay, Quebec, Canada.	W91-10565 2L
Water Related Gastrointestinal Illnesses.	W91-10946 2J	Environmental Management of the Puget
W91-10618 5B	Channel and Bank Stability of Wolf Creek and a	Sound.
Public Health Criteria for the Aquatic Environ-	Tributary at U.S. Highway 45 Near Wheeler,	W91-10577 5G
ment: Recent WHO Guidelines and Their Appli- cation.	Prentiss County, Mississippi.	Environmental Activism in the San Francisco
W91-10620 5G	W91-11107 2E	Bay Estuary. W91-10585 5G
Epidemiology of Human Cryptosporidiosis and	Morphology and Quantitative Analysis of Fluvi-	
the Water Route of Infection.	al Erosion Systems in the Hydrological Network of the Basque Country Autonomous Region.	National Estuary Program and Public Involve- ment.
W91-10643 5B	W91-11265 2J	W91-10590 5G
Determining Giardiasis Prevalence by Examina-	Flood Housed Zonation in Asid Lands	Pollutant Transport Manitoring and Prediction
tion of Sewage.	Flood-Hazard Zonation in Arid Lands. W91-11390 6F	Pollutant Transport Monitoring and Prediction by Mathematical Modelling: North Sea and Ad-
W91-10646 5A		jacent Estuaries.
Review of the Epidemiology and Diagnosis of	Dendrogeomorphic Approach to Estimating Slope Retreat, Maxey Flats, Kentucky.	W91-10600 5B
Waterborne Viral Infections. W91-10651 5B	W91-11395 2D	Seasonal Changes of Organic Carbon and Nitro-
	District and Boundaharst in Devlands	gen Production by Phytoplankton in the Estuary of River Tamagawa.
Incidence of Legionella in the Urban Environ- ment in Australia.	Piping and Pseudokarst in Drylands. W91-11561 2F	W91-10604 5B
W91-10929 5B		Improved Policy Instruments for Management
Fertility of Workers Chronically Exposed to	EROSION CONTROL  National Program for Soil and Water Conserva-	of Enclosed Coastal Seas and Estuaries: The
Chemically Contaminated Sewer Wastes.	tion. Its Effect on USDA Services.	Chesapeake Bay, USA.
W91-11316 5D	W91-11169 3F	W91-10610 2L
Results of the First Pilot-Scale Controlled	Roughness Coefficients of Watercourse Revet-	Pathways of Silver Uptake and Trophic Trans-
Cohort Epidemiological Investigation into the Possible Health Effects of Bathing in Seawater	ted With Half-Circular Concrete Pipes. Results	fer in Estuarine Organisms. W91-11337 5B
at Langland Bay, Swansea.	of Field Measurements in Watercourse S 333 at Maarkedal.	
W91-11366 5C	W91-11431 8B	Major Incident of Dioxin Contamination: Sedi- ments of New Jersey Estuaries.
EPILIMNION	To the Annual Control of the Control	W91-11341 5B
Phosphorus Losses from the Epilimnion in	Economic Analysis of Soil Conservation Tech- nologies.	Microbial Mats in Tidal Channels at San Carlos,
Rimov Reservoir. W91-11401 2H	W91-11566 4D	Baja California Sur, Mexico.
	Revegetation Technologies.	W91-11400 2L
EPINEPHRINE Decreased Norepinephrine and Epinephrine	W91-11568 4D	Hydrobiological Survey of the Chanomi Creek
Contents in Chromaffin Tissue of Rainbow	EROSION RATES	System, Lower Niger Delta, Nigeria.
Trout (Oncorhynchus mykiss) Exposed to	Advances in Wind and Water Erosion Predic-	W91-11524 5C
Diethyldithiocarbamate and Amylxanthate. W91-10901 5C	tion.	ESTUARINE ENVIRONMENT
EPIPHYTES	W91-10509 2J	Direct Detection of Enteropathogenic Bacteria in Estuarine Water Using Nucleic Acid Probes.
Effects of Acid Rain on Epiphytic Orchid	ERROR ANALYSIS	W91-10664 5A
Growth.	Statistical Analysis of Errors in Estimating Wet	Studies of Dissolved Carbohydrates (or Carbo-
W91-11076 5C	Deposition Using Five Surface Estimation Algo- rithms.	hydrate-Like Substances) in an Estuarine Envi-
EQUILIBRIUM	W91-10474 7B	ronment.
Energy Transformation-Ecology Interface from a Nonlinear, Nonequilibrium Thermodynamic	ESCHEDICHIA COLI	W91-10840 2L
Perspective.	ESCHERICHIA COLI  Effect of Heat Shock on Recovery of Escheri-	Voltammetric Determination of the Complexa-
W91-11085 5B	chia coli from Drinking Water.	tion Parameters of Zinc in Marine and Estuarine Waters.
EROSION	W91-10628 5F	W91-10924 2K
Advances in Wind and Water Erosion Predic-	Protective Effect of Glycine Betaine on Survival	Distribution of Dissolved Cadmium, Lead and
tion. W91-10509 2J	of Escherichia coli Cells in Marine Environ-	Copper in the Bristol Channel and the Outer
	ments. W91-10637 5B	Severn Estuary. W91-10925 5B
RUSLE: Revised Universal Soil Loss Equation. W91-10510 2J	11.0	
	Effect of Dissolved Nutrients and Inorganic Sus- pended Solids on the Survival of E. coli in	Microbial Mats in Tidal Channels at San Carlos,
WEPP: A New Generation of Erosion Predic- tion Technology.	Seawater.	Baja California Sur, Mexico. W91-11400 2L
W91-10511 2J	W91-10638 5B	
WEPP: Soil Erodibility Experiments for Range-	Miniaturized Fluorogenic Assays for Enumera-	ESTUARINE FISHERIES Rise and Fall of the Potomac River Striped Bass
land and Cropland Soils.	tion of E. coli and Enterococci in Marine Water.	Stock: A Hypothesis of the Role of Sewage.
W91-10512 2J	W91-10639 5A	W91-11529 5C

## ETHERS

ETHERS	Evaluation of Primary Production Loads and	EVALUATION
Anaerobic Treatability of a Phenolic Coal Con- version Wastewater After Diisopropyl Ether	Their Control in Enclosed Seas. W91-10524 5G	Water Management Issues for the Nineties. W91-10807
Extraction.		W 91-10007
W91-10939 5D	Field Survey and Hydraulic Study of 'Aoshio' in Tokyo Bay.	EVAPORATION Model of Ammonia Volatilization From Applied
EUCALYPTUS TREES	W91-10529 5C	Urea. V. The Effects of Steady-State Drainage
Rainfall Interception by Trees of Pinus radiata	Status of Eutrophication in the Great Barrier	and Evaporation.
and Eucalyptus viminalis in a 1300 mm Rainfall Area of Southeastern New South Wales: I.	Reef Lagoon.	W91-10805 3F
Gross Losses and Their Variability.	W91-10535 5B	Model of Ammonia Volatilization From Applied
W91-11345 2D	Eutrophication in Hiroshima Bay. W91-10536 5B	Urea. VI. The Effects of Transient-State Water Evaporation.
Rainfall Interception by Trees of Pinus radiata	W 71-10330	W91-10806 3F
and Eucalyptus viminalis in a 1300 mm Rainfall	Present State of Environmental Pollution in	77-10000
Area of Southeastern New South Wales: II. In- fluence of Wind-Borne Precipitation.	Coastal Sea Area and Measures for Protection. W91-10540 5B	Salinity and Evaporation in the River Murray Basin, Australia.
W91-11346 2D		W91-10989 2E
EUROPE	Impact of Nutrient Enrichment and Their Rela- tion to the Algal Bloom in the Adriatic Sea.	
EC Bathing Water Virological Standard: Is It	W91-10544 5C	Microwave Transmission, a New Tool in Forest
Realistic.	1171-10311	Hydrological Research.
W91-10622 5A	Changes and Stress Signs in Plankton Communi-	W91-10995 2I
Climatic Change and Future Agroclimatic Po-	ties as a Result of Man-Induced Perturbations in	Concept of Evaporation from Fresh and Saline
tential in Europe.	Enclosed Coastal Seas (Mediterranean, Baltic).	Water Bodies.
W91-10970 2B	W91-10547 5C	W91-11244 2D
	Bloom of Coscinodiscus wailesii and DO Deficit	
Sewage Sludge Treatment and Use: New Devel-	of Bottom Water in Seto Inland Sea.	Refinement of the Combination Equations for
opments, Technological Aspects and Environ-	W91-10549 5C	Evaporation.
mental Effects.	E 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	W91-11398 2K
W91-11115 5E	Ecological Modelling at Osaka Bay Related to	County Water Control of Francis - Providen
Production, Treatment and Handling of Sewage	Long-Term Eutrophication. W91-10556 5C	Ground-Water Control of Evaporite Deposition.
Sludge.	W 91-10330	W91-11438 2K
W91-11116 5D	Simulation of Bioecological and Water Quality	EVAPOTRANSPIRATION
	Processes in Enclosed Coastal Seas.	Hydrological Balance of Two Mediterranean
Modern Sludge Management: The Manager's	W91-10557 5C	Forested Catchments (Prades, Northeast Spain).
Choice. W91-11122 5D	Mariculture and Eutrophication in Jinhae Bay,	W91-10963 2A
W91-11122 3D	Korea.	
New Developments in Sampling Sludge Treated	W91-10558 5B	Heavy Metal Speciation in Sewage Sludge Fol-
Soils.		lowing a Phyto-Dewatering Treatment.
W91-11158 5A	Personal Computer System Supporting Water	W91-11147 5D
Regulatory Requirements for Pulp and Paper	Quality Management in Eutrophicated Bay. W91-10582 5G	Rainfall Interception by Trees of Pinus radiata
Mill Effluent Control: Scientific Basis and Con-	W71-10302	and Eucalyptus viminalis in a 1300 mm Rainfall
sequences.	Eutrophication Mechanisms of Coastal Seas in	Area of Southeastern New South Wales: I.
W91-11470 5G	Yamaguchi Prefecture.	Gross Losses and Their Variability.
ELIBORE LA DOCAMONTO CON DELIBORIO	W91-10593 5B	W91-11345 2D
EUROPEAN ECONOMIC COMMUNITY EC Bathing Water Virological Standard: Is It	Comparison of Nutritional Environment of	Beinfell Interception by Taxes of Disus sodiets
Realistic.	Closed Coastal Seas in Western Kyushu.	Rainfall Interception by Trees of Pinus radiata and Eucalyptus viminalis in a 1300 mm Rainfall
W91-10622 5A	W91-10595 2L	Area of Southeastern New South Wales: II. In-
	Dalar in Labe Barrers Grand by Laborat	fluence of Wind-Borne Precipitation.
EUTROPHIC ESTUARIES	Delay in Lake Recovery Caused by Internal Loading.	W91-11346 2D
Macroalgal-Sediment Nutrient Interactions and	W91-10886 2H	
Their Importance to Macroalgal Nutrition in a		Water Use of a Winter Wheat Cultivar (Triti-
Eutrophic Estuary. W91-10497 2L	Role of Phosphorus Cycling in Algal Metabo-	cum Aestivum).
W 31-10437	lism and Algal Succession in Lake Donghu,	W91-11436 3F
EUTROPHIC LAKES	China. W91-10897 5C	EXPANSIVE SOILS
Delay in Lake Recovery Caused by Internal	W91-10897	Numerical Modelling of Vertical Ground Move-
Loading.	Simplified Phosphorus Trophic State Model for	ments in Expansive Soils.
W91-10886 2H	Warm-Water Tropical Lakes.	W91-10945 2G
Ion Concentrations in Interstitial Water as Indi-	W91-11332 5C	
cators for Phosphorus Release Processes and	Phosphorus Losses from the Epilimnion in	EXPERIMENTAL DESIGN
Reactions.	Rimov Reservoir.	Scour at Cantilevered Pipe Outlets, Plunge, Pool
W91-10888 2K	W91-11401 2H	Energy Dissipator Design Criteria.
Multicomponent Kinetic Analysis of Iron Speci-		W91-10722 8B
ation in Humic Lake Tjeukemeer: Comparison	Natural Phosphate Source for Lake Waccamaw, North Carolina, USA.	Simple Design for Simultaneous Steady-State In-
of Fulvic Acid from the Drainage Basin and	W91-11405 2H	filtration Experiments with Ring Infiltrometers.
Lake Water Samples.	2N	W91-10813 7B
W91-11339 2H	Eutrophication of Pulp and Paper Wastewater	***************************************
	Recipients.	EXPERT SYSTEMS
EUTROPHICATION  Factorize of the Linear legical Releasing of Salter	W91-11509 5C	Knowledge-Based Systems and Operational Hy-
Features of the Limnological Behavior of Salto Grande's Reservoir (Argentina-Uruguay).	History of Cladocera in the Kleiner Barsch-See,	drology.
W91-10491 5C	an Acidic, Calcium-Poor, Marshy Pond in the	W91-11273 7C
	Middle European Flatland (Die Geschichte der	EXPLOSIONS
Runoff Characteristics of COD, BOD, C, N, and	Cladocerenfauna des Kleinen Barsch-Sees, eines	
P Loadings from Rivers to Enclosed Coastal	Sauren, Kalkarmen Moorweihers im Mitteleuro-	Abbeystead Outfall Works: Background to Re- pairs and Modifications and Lessons Learned.
Seas.	paischen Flachland).	W91-11355 5D
W91-10521 5B	W91-11515 2H	

EXPLOSIVES	Nitrate Removal by Denitrification in Alluvial	Aeromonas Species Stabilization Ponds in the
Remedial Investigation of the High Explosives	Ground Water: Role of a Former Channel.	Arid Region of Marrakesh, Morocco, and Rela-
Burn Pit Facility, Building 829 Complex, Law-	W91-10909 5B	tion to Fecal-Pollution and Climatic Factors.
rence Livermore National Laboratory Site 300.	Transformation of (C-14)-2,4-Dichlorophenol in	W91-10842 5D
W91-10731 5B	Saskatchewan Soils.	FEDERAL JURISDICTION
FALLOUT	W91-10922 5B	Future Water Management Problems: The Fed-
Dynamic Model of Caesium Transport in Lakes	Pi-1	eral Role In Their Solution.
and Their Catchments.	Biodegradation of Chemicals at Trace Concen-	W91-11210 4A
W91-10934 5B	trations. W91-11102 5B	
	W 91-11102 3B	Dynamics of Water Policy.
Evidence of Chernobyl Fallout on a Temperate	Transport and Fate of Acetone in an Outdoor	W91-11212 6E
Himalayan Glacier.	Model Stream, Stennis Space Center near Bay	THE LINE OF THE OWN
W91-10950 5B	St. Louis, Mississippi.	FENITROTHION
Use of 137Cs as a Tracer in an Erosion Study in	W91-11103 5B	Contamination of Ponds by Fenitrothion during
South Limburg (The Netherlands) and the Influ-	Disdonadation of Understaken Veneza in the	Forest Spraying.
ence of Chernobyl Fallout.	Biodegradation of Hydrocarbon Vapors in the Unsaturated Zone.	W91-11298 5B
W91-11351 7B	W91-11227 5B	FERNS
	***************************************	Ultrastructural and Biochemical Effects of Cad-
FARM MANAGEMENT	Multimethod for Pesticides in Soil at Trace	mium on the Aquatic Fern Marsilea minuta
Agrichemicals and Ground Water: Assumptions	Level.	Linn.
about Farmer Information Processes.	W91-11309 5A	W91-10829 5C
W91-11163 6B	Debusies of the Empiride MDAMT in Water	
W. W. C. W. C. CONTO	Behavior of the Fungicide MBAMT in Water. W91-11315 5A	Temperatures Lethal to Salvinia molesta Mitch-
FARM WASTES	W91-11315 5A	ell.
Control of Enteric Micro-organisms by Aerobic-	Distribution of Chlorobenzenes in the Bottom	W91-11450 2H
Thermophilic Co-Composting of Wastewater	Sediments of Ise Bay.	PEDTH PPV
Sludge and Agro-Industry Sludge.	W91-11324 5B	FERTILITY
W91-10693 5E		Fertility of Workers Chronically Exposed to
New Developments in Processing of Sludges	Behavior of Chlorobenzenes in Ise Bay, Estimat-	Chemically Contaminated Sewer Wastes.
and Slurries.	ed from Their Concentrations in Various Envi-	W91-11316 5D
W91-10699 5D	ronmental Media.	FERTILIZATION
W 91-10099	W91-11325 5B	Model of Ammonia Volatilization From Applied
Dutch Approach to Manure Processing.	Electrolytic Model System for Reductive Deha-	Urea. V. The Effects of Steady-State Drainage
W91-10703 5D	logenation in Aqueous Environments.	and Evaporation.
	W91-11343 5B	W91-10805 3F
Hong Kong: Can the Dragon Clean its Nest.		W 51-10003
W91-11439 5G	Stimulation of the Reductive Dechlorination of	FERTILIZER MANAGEMENT
	Tetrachloroethene in Anaerobic Aquifer Micro-	Soil Tec: A Computerized Soil-Specific Fertiliz
FATE OF POLLUTANTS	cosms by the Addition of Toluene.	er Application System.
Oil Spills in Mangroves: A Conceptual Model	W91-11344 5B	W91-11197 7C
Based on Long-term Field Observations.	A queous Photolusis of Nanzonamida	
W91-10489 5B	Aqueous Photolysis of Napropamide. W91-11376 5B	Professionalism in Agriculture: Seeking a Train
Scavenging Processes of Marine Particles in	W 91-11370 3D	ing Standard.
Osaka Bay.	Microbial Dechlorination of the Herbicide Me-	W91-11198 50
W91-10538 5B	tolachlor.	
	W91-11377 5B	FERTILIZERS
Use of Respiration in the Sandy Beach or on the		Dutch Approach to Manure Processing.
Tidal Flat: 1. Permeable Sandy Beach.	Groundwater Contamination By Anthropogenic	W91-10703 5I
W91-10541 5G	Organic Compounds From Waste Disposal	Processing Organic Waste Products to Black
0 10 00 00 10 100	Sites: Transformations and Behavior. W91-11378 5B	Soil and Organic Fertilizers.
Seasonal Changes of Organic Carbon and Nitro-	W91-113/8	W91-10705 51
gen Production by Phytoplankton in the Estuary	Nitrogen Dynamics of Pulp and Paper Sludge	117110100
of River Tamagawa. W91-10604 5B	Amendment to Forest Soils.	Model of Ammonia Volatilization From Applie
W91-10604 5B	W91-11510 5E	Urea. VI. The Effects of Transient-State Water
Species and Genera of Enterobacteriaceae in		Evaporation.
River Neckar and After River Bank Filtration	Fate and Transport of Sediment-Associated	W91-10806 31
and Their Resistance Patterns to Antibiotics and	Contaminants.	
Heavy Metal Salts.	W91-11587 5B	Effect of Long-Term Application of Fertilizer
W91-10675 5B	FECAL BACTERIA	on the Agrophysical Properties of an Irrigate
	Evaluation of Fecal Enterococci Isolation Media	Light-Chestnut Soil.
Bdellovibrio sp.: A Predator under Groundwat-	to Indicate Fecal Pollution in Chlorinated	W91-10914 20
er Conditions. A Short Communication.	Water.	Alternative Uses of Sludge Other than Agricul
W91-10676 5B	W91-10626 5F	tural.
Treatability of Hazardous Chemicals in Soils:		W91-11120 51
Volatile and Semivolatile Organics.	Staphylococci in Polluted Waters and in Waters	
W91-10712 5B	of Uninhabited Areas.	Modifications of Some Physical Properties i
11 22 10/12 JB	W91-10631 5B	Two Compost-Amended Italian Soils.
Sorption Phenomena in Subsurface Systems:	Destruction of Faecal Bacteria, Enteroviruses	W91-11148 51
Concepts, Models, and Effects on Contaminant	and Ova of Parasites in Wastewater Sludge by	
Fate and Transport.	Aerobic Thermophilic and Anaerobic Mesophi-	Use of Sewage Sludge on Agricultural Land
W91-10882 5B	lic Digestion.	Impact on Soil Fauna.
	W91-10688 5D	W91-11150 5
Fate and Effects of Semivolatile Organic Pollut-		Existing Conditions for Agricultural Utilization
ants During Anaerobic Digestion of Sludge.	Distribution of Fecal Pollution Indicator Bacte-	of Sewage Sludge Compost in Japan.
W91-10884 5D	ria in Lake Kinneret.	
Fate of Acetone in an Outdoor Model Stream	W91-11322 5B	W 31-11134 3
with a Nitrate Supplement, Southern Mississippi,	FECAL COLIFORMS	Studies for a Simultaneous Use of Liqui
U.S.A.	Polyvalent Coliphages in Sewage.	Manure and Sewage Sludge.
W91-10903 5B		W91-11157 5

### **FERTILIZERS**

Chemical Properties of Sewage Sludges Pro-	Trends In Water Pollution Control In the Finn-	FISH MORTALITY
duced in the Valencian Area (Spain). W91-11159 5A	ish Pulp and Paper Industry. W91-11468 5G	Coal Mine Waters and Their Influence on the Purity Ecological State of River and the Fish
Slurry and Sludge Spreading Methods.	Monitoring of Organochlorine Compounds In	Production. W91-10605 5B
W91-11161 5E	Finnish Inland Waters Polluted by Pulp and	
Soil Tec: A Computerized Soil-Specific Fertiliz-	Paper Effluents Using the Mussel Incubation	FISH PASSAGES
er Application System.	Method. W91-11507 5A	Hydraulics of Culvert Fishways IV: Spoiler Baffle Culvert Fishways.
W91-11197 7C	W91-11507 5A	W91-11279 8I
Trickle Irrigation of Sunflower With Municipal	FISH	
Wastewater.	Construction of Artificial Seaweed Bed Accom-	FISH PATHOLOGY Enhancement of Hepatocarcinogenesis in Rain-
W91-11435 3F	panied with the Reclamation for Unit No. 3 of Ikata Power Station.	bow Trout with Carbon Tetrachloride.
FIELD TESTS	W91-10603 2L	W91-11301 5C
Field Test of Electroosmotic Strengthening of		FISH PHYSIOLOGY
Soft Sensitive Clay.	Atrazine Hazards to Fish, Wildlife, and Inverte- brates: A Synoptic Review.	Bioaccumulation, Elimination and Metabolism of
W91-10778 8D	W91-10709 5C	Triphenyltin Chloride by Early Life Stages of
Field Sampling of Residual Aviation Gasoline in		Minnows Phoxinus phoxinus.
Sandy Soil.	Seasonal Variations of Aliphatic Hydrocarbons	W91-10877 5B
W91-10795 5A	in Sardina pilchardus (Walb.) (Teleostei: Clupei- dae) Tissues.	Mercury Body Burden and Otolith Characteris-
Method for Installing Miniature Multilevel Sam-	W91-10839 5B	tics of Bluefin Tuna from the Northwest Medi-
pling Wells.		terranean (Balearic Sea).
W91-10962 5A	Standard Test Fish for India and the Neighbor-	W91-10881 2L
FILTERS	ing Countries. W91-11300 5A	Decreased Norepinephrine and Epinephrine
Adsorption of Viruses by Diatomaceous Earth	W71-11300	Contents in Chromaffin Tissue of Rainbow
Coated with Metallic Oxides and Metallic Per-	Fish Fauna of Various Bodies of Stagnant Water	Trout (Oncorhynchus mykiss) Exposed to Diethyldithiocarbamate and Amylxanthate.
oxides. W91-10659 5A	Near Concepcion (Paraguay) (Zur Fischfauna Einiger Stehender Gewasser bei Concepcion	W91-10901 5C
W91-10039 3A	(Paraguay)).	
Package Water Plant Filters to 0.02 N.T.U.	W91-11523 2H	Chemical and Biological Factors Affecting Acid Tolerance of Smallmouth Bass.
W91-11225 5F	Divitale White Head Court 64 - 0	W91-11530 5C
FILTRATION	Distribution, Habitat Use, and Growth of Age-0 Colorado Squawfish in the Green River Basin,	
Improvement of the Zeta-Plus Filter Method for	Colorado and Utah.	FISH POPULATIONS Occurrence of a South American Armored Cat-
Concentration of Viruses from Water.	W91-11534 2H	fish in the Hillsborough River, Florida.
W91-10655 5A	FISH ESTABLISHMENT	W91-10855 2H
Comparison of Pressurized and Gravity Distri-	Occurrence of a South American Armored Cat-	CLIA- I- DIA Wasterland Division I D
bution Systems for Wastewater Treatment.	fish in the Hillsborough River, Florida.	Shifts in Fish Vertical Distribution in Response to an Internal Seiche in a Stratified Lake.
W91-10845 5D	W91-10855 2H	W91-10864 2H
Efficiency of an Ozoflotation-Filtration Process	DICH PARATNO	
for the Treatment of the River Thames at	FISH FARMING Benthic Faunal Succession in a Cove Organical-	Effect of Three Primary Treatment Sewage Outfalls on Metal Concentrations in the Fish
Walton Works. W91-11268 5F	ly Polluted by Fish Farming.	Cheilodactylus fuscus Collected Along the
	W91-10554 5C	Coast of Sydney, Australia.
Use of a Backflush Technique in Cross-flow	Production of Chironomid Larvae in Culturing	W91-10873 5B
Microfiltration for Treating Natural Water and Filter Backwash Wastewater in Water Works.	Media of Various Organic Wastes.	Mercury Body Burden and Otolith Characteris-
W91-11270 5F	W91-11526 8I	tics of Bluefin Tuna from the Northwest Medi-
Limit Effects New Column to Old Book	EIGH FOOD	terranean (Balearic Sea).
Liquid Effluents: New Solutions to Old Prob- lems.	FISH FOOD Production of Chironomid Larvae in Culturing	W91-10881 2L
W91-11360 5D	Media of Various Organic Wastes.	Rise and Fall of the Potomac River Striped Bass
	W91-11526 8I	Stock: A Hypothesis of the Role of Sewage.
Study on Triple-Membrane-Separator (TMS) Process to Treat Aqueous Effluents Containing	FISH HARVEST	W91-11529 5C
Uranium.	Estimation of Sport Fish Harvest for Risk and	Upstream Extirpation of Four Minnow Species
W91-11367 5D	Hazard Assessment of Environmental Contami-	Due to Damming of a Prairie Stream.
Treatment of Bleach-Plant Effluents with Mem-	nants.	W91-11535 6G
brane Filtration and Sorption Techniques.	W91-11556 5G	Use of the Intertidal Zone by Fish in Nova
W91-11489 5D	FISH HATCHERIES	Scotia.
Membrane Filtration Combined with Biological	Quality of Salmonid Hatchery Effluents During	W91-11557 2L
Treatment for Purification of Bleach Plant Ef-	a Summer Low-Flow Season.	FISHERIES
fluents.	W91-11532 5D	Change of Oceanic Condition by the Man-Made
W91-11490 5D	FISH LARVAE	Structure for Upwelling.
FINITE ELEMENT METHOD	Drift of the Characin Larvae, Bryconamericus	W91-10542 8I
Analysis of Three-Dimensional Ground Move-	deuterodonoides, During the Dry Season from	Benthic Faunal Succession in a Cove Organical-
ments: The Thunder Bay Tunnel.	Andean Piedmont Streams.	ly Polluted by Fish Farming.
W91-10775 8A	W91-11560 2H	W91-10554 5C
Finite-Element Analysis of Softening Effects in	FISH MANAGEMENT	Mariculture and Eutrophication in Jinhae Bay,
Fissured, Overconsolidated Clays and Mud-	Pacific Salmon at the Crossroads: Stocks at Risk	Korea.
stones. W91-10776 8D	from California, Oregon, Idaho, and Washing- ton.	W91-10558 5B
	W91-10834 8I	Studies on the Situation of Pollution and Coun-
FINLAND		termeasures of Control of the Oceanic Environ-
Effects of Climate Change on Discharges and Snow Cover in Finland.	Habitat Use by an Assemblage of Fish in a Large Warmwater Stream.	ment in Zhoushan Fishing Ground: The Largest Fishing Ground in China.
W91-10964 2C	W91-11533 2H	W91-10559 5C

Strategies for Restoring and Developing Fish Habitats in the Strait of Georgia: Puget Sound Inland Sea, Northeast Pacific Ocean.	Future Directions for Water Resources. W91-11208 4A	Delineation of Flooding within the Ozark Na- tional Scenic Riverways in Southeastern Missou- ri-Round Spring and Powder Mill.
W91-10568 5G	Fenay Beck Flood-Alleviation Scheme. W91-11365 8A	W91-11579 2E
Coal Mine Waters and Their Influence on the	W 71-11303	FLOODPROOFING
Purity Ecological State of River and the Fish	Flood-Hazard Zonation in Arid Lands.	Fenay Beck Flood-Alleviation Scheme.
Production.	W91-11390 6F	W91-11365 8A
W91-10605 5B		W 91-11303
W 21-10003	Analysis of Alternative Modifications for Re-	FLOODS
Aquatic Habitat Measurement and Valuation:	ducing Backwater Flooding at the Honey Creek	Snow and Ice Perturbation during Historical
Imputing Social Benefits to Instream Flow	Coal Strip Mine Reclamation Site in Henry	Volcanic Eruptions and the Formation of
Levels.	County, Missouri.	Lahars and Floods.
W91-11266 7C	W91-11595 2E	W91-11394 2C
		W91-11394 2C
Assessing Stream Values: Perspectives of Aquat-	FLOOD-CONTROL STORAGE	Paleohydrologic Techniques Used to Define the
ic Resource Professionals.	Dallas' Flood Caverns.	Spatial Occurrence of Floods.
W91-11425 8I	W91-10493 8A	W91-11396 2E
		W)1-11570
Review of Fisheries Habitat Improvement	FLOOD FLOW	Models of Seasonal Growth of the Equatorial
Projects in Warmwater Streams, with Recom-	Update of Flood-Flow Characteristics of Nancy	Carp Labeo dussumieri in Response to the River
mendations for Wisconsin.	Creek at Georgia Highway 400 Extension Near	Flood Cycle.
W91-11591 2H	Atlanta, Georgia.	W91-11559 2H
FISHING	W91-10762 2E	
		FLORIDA
Evaluating the Impact of Water Quality Upon	FLOOD FORECASTING	Land Use, Water Use, Streamflow Characteris-
the Value of Recreational Fishing. W91-11058 6G	Unit Hydrographs for Developing Design Flood	tics, and Water-Quality Characteristics of the
W91-11058 6G	Hydrographs.	Charlotte Harbor Inflow Area, Florida.
FLAGELLATES	W91-10809 2E	W91-10771 4C
Life Cycle Strategies of the Red Tide Causing	Dynamic-Stochastic Models of Rainfall and	
Flagellates Chattonella (Raphidophyceae) in the	Snowmelt Runoff Formation.	Macrophyte Standing Crop and Primary Pro-
Seto Inland Sea.	W91-10967 2A	ductivity in Some Florida Spring-Runs.
W91-10546 5B	W91-10907 ZA	W91-10812 2E
W 31-10340	Flood Forecasts on Transboundary Rivers in	
FLASH FLOODS	Hungary with Parallels in Canada.	Wetland Impoundments of East-Central Florida.
Short-Term Effects of a Catastrophic Beaver	W91-11015 4A	W91-10854 2L
Dam Collapse on a Stream Fish Community.	W31-11013	
W91-11558 2E	Paleohydrologic Techniques Used to Define the	Occurrence of a South American Armored Cat-
	Spatial Occurrence of Floods.	fish in the Hillsborough River, Florida.
FLIES	W91-11396 2E	W91-10855 2H
Use of Bacillus thuringiensis var. israelensis to		N- B-i- C I di C Ni-t-i
Control the Nuisance Fly Sylvicola fenestralis	FLOOD FREQUENCY	Non-Point Source Loadings of Nutrients and Dissolved Organic Carbon from an Agricultural-
(Anisopodidae) in Sewage Filter Beds.	Dynamic-Stochastic Models of Rainfall and	
W91-10890 5D	Snowmelt Runoff Formation.	Suburban Watershed in East Central Florida.
THE POOR IS A STREET	W91-10967 2A	W91-10927 5B
FLOCCULATION A Post of the North		Assessment of Hydrogeologic Conditions with
Rotavirus Detection: A Problem that Needs	FLOOD HYDROGRAPHS	Emphasis on Water Quality and Wastewater In-
Concentration.	Unit Hydrographs for Developing Design Flood	jection, Southwest Sarasota and West Charlotte
W91-10656 5A	Hydrographs.	Counties, Florida.
Flocculation of Micro-organisms.	W91-10809 2E	W91-11087 2F
W91-11267 5F	FLOOD PLAIN ZONING	W 91-11007
1171-11201	Flood-Hazard Zonation in Arid Lands.	Hydrology of the Floridan Aquifer System in
Criteria for Flocculator Design.	W91-11390 6F	East-Central Florida.
W91-11269 5F	W91-11390 OF	W91-11113 2F
	FLOOD PLAINS	
Decrease of Pollutant Level of Bleaching Ef-	Secondary Salinization of Soils of the Dniester	Florida's Pesticide Water Quality Education
fluents and Winning Valuable Products by Suc-	Delta Floodplain.	Program.
cessive Flocculation and Microbial Growth.	W91-10917 2G	W91-11202 5G
W91-11488 5D		
TOOR BACKET	Computation of Uniform Flow in Open Chan-	FLORIDAN AQUIFER
FLOOD BASINS	nels with Flood Plains.	Hydrology of the Floridan Aquifer System in
Exporting Himalayan Floods.	W91-11281 2E	East-Central Florida.
W91-11014 2E		W91-11113 2F
Flood Forecasts on Transboundary Rivers in	FLOOD ROUTING	
Hungary with Parallels in Canada.	Dallas' Flood Caverns.	FLOW
W91-11015 4A	W91-10493 8A	Comparison of Measured and Estimated Unsatu-
W 31-11013		rated Hydraulic Conductivities During Snow-
FLOOD CONTROL	FLOODING	melt.
Dallas' Flood Caverns.	Rhine Rift Valley Groundwater-River Interac-	W91-10904 2G
W91-10493 8A	tions: Evolution of their Susceptibility to Pollu-	FLOW CHARACTERISTICS
	tion.	
Flow Control Technology for Enhancement and	W91-10849 5B	Estimating Flow Characteristics at Ungauged
Diverse Use of the Marine Environment.	Deleghadesia Test-inner Head to D.C. st.	Sites.
W91-10607 2L	Paleohydrologic Techniques Used to Define the	W91-11545 2E
	Spatial Occurrence of Floods.	FLOW CONTROL
Rhine Rift Valley Groundwater-River Interac-	W91-11396 2E	Managing Water Resources in Latin America
tions: Evolution of their Susceptibility to Pollu-	Influence of Flooded Soil on Chemical Compo-	
tion.	sition of Annual Ryegrass and Digestibility by	W91-11385 6E
W91-10849 5B		FLOW DISCHARGE
0 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Meadow Voles. W91-11536 2I	Pollution and Protection of Bohai Bay.
Secondary Salinization of Soils of the Dniester	W91-11536 2I	W91-10522 5E
Delta Floodplain.	Delineation of Flooding within the Ozark Na-	VI 21-10322
W91-10917 2G	tional Scenic Riverways in Southeastern Missou-	Runoff Analysis of the Chang Jiang (The
Experting Himsleven Floods	ri-Akers and Alley Spring.	Yangtze River).
Exporting Himalayan Floods. W91-11014 2E		W91-10966 2E
1771-11017		

## FLOW EQUATIONS

FLOW EQUATIONS Similarity Solutions of the Shallow Water Equa-	FLUORESCENCE Miniaturized Fluorogenic Assays for Enumera-	Budgets of Selected Cations and Anions in Two Forested Experimental Watersheds in Central
tions. W91-10987 8B	tion of E. coli and Enterococci in Marine Water. W91-10639 5A	Greece. W91-11550 4C
	Salmonella Detection in Sewage Waters Using	
Computation of Uniform Flow in Open Chan- nels with Flood Plains. W91-11281 2E	Fluorescent Antibodies. W91-10687 5D	FORESTS Interannual Variability in Acidic Deposition on
	FOAMING	the Mt. Mitchell Area Forest. W91-10478 5B
Correction Coefficients for Uniform Channel	Foaming in Activated Sludge Plants: A Survey	
Flow. W91-11282 2E	in Queensland, Australia and an Evaluation of Some Control Strategies.	Effects of Land Use Alteration on Tropical Carbon Exchange.
FLOW MODELS	W91-11328 5D	W91-11072 4C
Delineation of Traveltime-Related Capture	FOG	FOSSILS
Areas of Wells Using Analytical Flow Models and Particle-Tracking Analysis. W91-10957 2F	Meteorology and Oceanography in the Seto Inland Sea. W91-10520 2L	Analysis of Subfossil Shelled Protozoa in the Sediments of a Small Acid Forest Lake (Kleiner Barsch-See, Northern GDR) (Analyse Subfos-
Analysis of Large Scale Water Distribution Sys-		siler Protozoenschalen der Sedimente eines
iems.	FOOD CHAINS Pathways of Silver Uptake and Trophic Trans-	Kleinen Sauren Waldsees) (Kleiner Barsch-See,
W91-10983 5F	fer in Estuarine Organisms.	Nordliche DDR). W91-11516 2H
Open Channel Velocity Profiles over a Zone of	W91-11337 5B	W71-11310
Rapid Infiltration.	FORAGES	FOUNDATION FAILURE
W91-10984 8B	Influence of Flooded Soil on Chemical Compo- sition of Annual Ryegrass and Digestibility by	Analysis of a Sanitary-Embankment Failure Over the Rio de Janeiro Soft Clay Deposit.
Computation of Uniform Flow in Open Chan-	Meadow Voles.	W91-10780 8D
nels with Flood Plains. W91-11281 2E	W91-11536 2I	Deep-Seated Consolidation Settlements in the
	FORCED DRYING	Fraser River Delta.
Solution in Closed Form and a Series Solution to	Evaporative Drying of Dredged Material.	W91-10948 8D
Replace the Tables for the Thickness of the Equivalent Layer in Hooghoudt's Drain Spacing	W91-11000 5D	FRACTALS
Formula.	FOREST ECOSYSTEMS	Diffusion in Fractal Porous Media.
W91-11430 2G	Rainfall Interception by Trees of Pinus radiata and Eucalyptus viminalis in a 1300 mm Rainfall	W91-11243 2F
FLOW PATTERN	Area of Southeastern New South Wales: I.	FRANCE
Effect of Decoupled Low-Level Flow on	Gross Losses and Their Variability.	Impact of Coastal Development on the Infralit-
Winter Orographic Clouds and Precipitation in the Yampa River Valley.	W91-11345 2D	toral Zone Along the Southeastern Mediterrane- an Shore of Continental France.
W91-11410 2B	FOREST HYDROLOGY Rainfall Interception and Boundary Layer Con-	W91-10562 6G
FLOW VELOCITY	ductance in Relation to Tree Spacing.	Y - 1 C 1 M C C
Thermal-Pulse Flowmeter for Measuring Slow Water Velocities in Boreholes.	W91-10905 2I	Legal System and Management of Southern France Lagoons.
W91-10766 8G	Throughflow and Solute Transport in an Isolat- ed Sloping Soil Block in a Forested Catchment.	W91-10611 5G
Regulatory Influence of Water Current on Algal	W91-10993 2G	Wastewater and Giardia Cysts. W91-10648 5B
Colonization in an Unshaded Stream at Shillong (Meghalaya, India).	Microwave Transmission, a New Tool in Forest	
W91-11451 2E	Hydrological Research. W91-10995 2I	Interrelations Between Amoebae and Bacteria in the Moselle River, France.
FLOWMETERS	FOREST MANAGEMENT	W91-10650 5B
Thermal-Pulse Flowmeter for Measuring Slow	Contamination of Ponds by Fenitrothion during	Sludge Recycling in Agriculture Compared with
Water Velocities in Boreholes.	Forest Spraying.	Other Disposal Methods in France.
W91-10766 8G	W91-11298 5B	W91-11137 5E
FLUCTUATIONS	FOREST SOILS	Use of Municipal Sewage Sludge in Agriculture:
Fluctuating Water Levels in the Great Lakes-St. Lawrence River Basin: An Evaluation Frame-	Throughflow and Solute Transport in an Isolat- ed Sloping Soil Block in a Forested Catchment.	The Role of the Water Authorities.  W91-11138  5D
work for the Analysis of Potential Actions. W91-11026 6B	W91-10993 2G	Examples of Agricultural Use of Residual
Fluctuating Great Lakes Water Levels: Progress	Nitrogen Dynamics of Pulp and Paper Sludge Amendment to Forest Soils.	Sludge.
and Opportunities.	W91-11510 5E	W91-11139 5D
W91-11032 6A	FOREST WATERSHEDS	FRANKLIN LAKE PLAYA
Fluctuating Water Levels: An Issue Manage-	Hydrogeochemical Processes Controlling Sub- surface Transport from an Upper Subcatchment	Hydrologic, Meteorological, and Unsaturated- Zone Moisture-Content Data, Franking Lake
ment Approach. W91-11033 6B	of Walker Branch Watershed During Storm	Playa, Inyo County, California.
	Events. 1. Hydrologic Transport Processes. W91-10907 5B	W91-11089 2F
FLUIDIZED BED PROCESS  Mathematical Modelling for Sulphur Dioxide		FREE TRADE
Removal from Stack Gases in a Fluidized Bed of Activated Sodium Carbonate.	Hydrological Balance of Two Mediterranean Forested Catchments (Prades, Northeast Spain).	Will Free Trade Drink Canada Dry. W91-11041 6D
W91-11080 5G	W91-10963 2A	
	Budgets of Selected Cations and Anions in Two	FREEZE-THAW TESTS
Oxic Fluidized-Bed Treatment of Dichlorophen-	Forested Experimental Watersheds in Central	Predicting Concrete Service Life in Cases of Deterioration Due to Freezing and Thawing.
ols. W91-11485 5D	Greece. W91-11550 4C	W91-10734 8F
FLUIDIZED BEDS Treatment of Bleaching Effluents In Aerobic/	FORESTRY Alternative Uses of Sludge Other than Agricul-	FREQUENCY CONTROL  Experience with Low-Head HydroPlant Fre-
Anaerobic Fluidized Biofilm Systems.	tural.	quency Control.
W91-11486 5D	W91-11120 5E	W91-11214 8C

FRESHWATER MUSSELS	Environmental Control Impacts of Selected Al-	GELS
Phenyltins in Water, Sediment, and Biota of	ternate Fuels on Existing Power Plants.	Detoxification by Sephadex LH20 of Seafood
Freshwater Marinas.	W91-11078 5G	Concentrates for Rotavirus Assay.
W91-11342 5B	Don't Brown and France of Water Brown	W91-10696 5A
Monitoring of Organochlorine Compounds In	Past, Present, and Future of Water Resources Management In the United States.	GENE PROBES
Finnish Inland Waters Polluted by Pulp and	W91-11207 4A	Direct Detection of Enteropathogenic Bacteria
Paper Effluents Using the Mussel Incubation	W91-1120/ 4A	in Estuarine Water Using Nucleic Acid Probes.
Method.	Future Directions for Water Resources.	W91-10664 5A
W91-11507 5A	W91-11208 4A	1171-10001
		Detection of Hepatitis A Virus and Other Enter-
FROGS	Past, Present, and Future of Water Use and	oviruses in Wastewater and Surface Water Sam-
Initial Evaluation of Developmental Malforma-	Management.	ples by Gene Probe Assay.
tion as an End Point in Mixture Toxicity Hazard	W91-11209 4A	W91-10665 5A
Assessment for Aquatic Vertebrates.	Future Water Management Problems: The Fed-	Detection of Belieview in Weter her Direct Inc.
W91-10832 5C	eral Role In Their Solution.	Detection of Poliovirus in Water by Direct Iso-
FROZEN SOILS	W91-11210 4A	lation of the RNA and Hybridization with Gene Probes.
	W91-11210 4A	
Spatial and Temporal Influence of Soil Frost on	GABCIKOVO-NAGYMAROS POWER DAM	W91-10666 5A
Infiltration and Erosion of Sagebrush Range- lands.	PROJECT	Application of a Poliovirus cDNA Probe for the
W91-10820 2G	Resolving Conflicts on the Danube: The Gabci-	Detection of Enteroviruses in Water.
W 91-10020 2G	kovo-Nagymaros Power Dam Project.	W91-10667 5A
FUEL	W91-11018 6B	
Sludge Management by Thermal Conversion to	777	Detection of Rotaviruses in Water by Gene
Fuels.	GAGES	Probes.
W91-10706 5D	Automatic Tracer-Dilution Method Used for	W91-10668 5A
	Stage-Discharge Ratings and Streamflow Hy-	CONTRACTOR OF
Environmental Control Impacts of Selected Al-	drographs on Small Iowa Streams.	GENETICS
ternate Fuels on Existing Power Plants.	W91-11111 7B	Effects of Pollution on Heterozygosity in the
W91-11078 5G		Barnacle Balanus amphitrite (Cirripedia: Thora-
	GAGING STATIONS	cica).
FULVIC ACIDS	Levels at Streamflow Gaging Stations.	W91-10518 5C
Multicomponent Kinetic Analysis of Iron Speci-	W91-11586 7B	Direct Detection of Enteropathogenic Bacteria
ation in Humic Lake Tjeukemeer: Comparison	CINE TITLE	in Estuarine Water Using Nucleic Acid Probes.
of Fulvic Acid from the Drainage Basin and	GAME THEORY	W91-10664 SA
Lake Water Samples.	Water Diversion from the Great Lakes as a	W 91-10004
W91-11339 2H	Dynamic Game.	Detection of Poliovirus in Water by Direct Iso-
FUNDING	W91-11051 6B	lation of the RNA and Hybridization with Gene
Funding Groundwater Protection Programs:	GAS CHROMATOGRAPHY	Probes.
Iowa's Groundwater Protection Fund.	Determination of Effective Diffusion Coeffi-	W91-10666 5A
W91-11179 5G	cients for Gaseous and Dissolved Organic Sub-	
w)1-1117/	stances in Soil Material Using a 'Stopped Elu-	Detection of Rotaviruses in Water by Gene
Funding New York State's Integrated Pest Man-	tion' Method with HPLC and GC.	Probes.
agement Program.	W91-10802 7B	W91-10668 5A
W91-11180 6C	W 91-10002	CROCHENICAL CVCI PC
	Use of 2,2-Dimethoxypropane for the Direct	GEOCHEMICAL CYCLES
FUNGI	Gas Chromatographic-Mass Spectrometric De-	Assimilation of Metals in Marine Copepods and its Biogeochemical Implications.
Effect of Coal-Mine Effluent on Fungal Assem-	termination of Some Organic Compounds in	W91-10866 2L
blages and Leaf Breakdown.	Water.	W 91-10800
W91-11320 5C	W91-11245 5A	GEOCHEMISTRY
Treatment and Detarification of Assessed		Ground-Water Flow and Solute Movement to
Treatment and Detoxification of Aqueous	Capillary Column Gas Chromatography With	Drain Laterals, Western San Joaquin Valley
Spruce Bark Extracts by Aspergillus niger. W91-11481 5D	Nitrogen-Phosphorus Detection for Determina-	California. I. Geochemical Assessment.
W91-11481 5D	tion of Nitrogen-and Phosphorus-Containing	W91-10768 5E
Onset of Lignin-Modifying Enzymes, Decrease	Pesticides in Finished Drinking Waters: Collabo-	
of AOX and Color Removal by White-Rot	rative Study.	Geochemical Evidence Supporting T. C. Cham-
Fungi Grown on Bleach Plant Effluents.	W91-11259 5A	berlin's Theory of Glaciation.
W91-11487 5D	D. C.	W91-10790 2C
	Determination of Nitroaromatics and Nitramines	Coundman Plans and the Maria Country
Decrease of Pollutant Level of Bleaching Ef-	in Ground and Drinking Water by Wide-Bore	Groundwater Flow and the Metal Content of
fluents and Winning Valuable Products by Suc-	Capillary Gas Chromatography.	Peat.
cessive Flocculation and Microbial Growth.	W91-11262 5A	W91-10902 2F
W91-11488 5D	Multimethod for Pesticides in Soil at Trace	Hydrogeochemical Processes Controlling Sub
	Level.	surface Transport from an Upper Subcatchmen
FUNGICIDES	W91-11309 5A	of Walker Branch Watershed During Storm
Bioaccumulation, Elimination and Metabolism		Events. 1. Hydrologic Transport Processes.
of Triphenyltin Chloride by Early Life Stages of	Determination of Herbicide Residues in Soil in	W91-10907 51
Minnows Phoxinus phoxinus.	the Presence of Persistent Organochlorine Insec-	
W91-10877 5B	ticides.	Hydrogeochemical Processes Controlling Sub
Transport of the Fungicide Chlorothalonil from	W91-11310 5A	surface Transport from an Upper Subcatchmen
Its Operational Use on a Pond Ecosystem.		of Walker Branch Watershed During Storm
W91-11299 5B	GASOLINE	Events. 2. Solute Transport Processes.
W 21-11427 JB	Impact of Recharge Through Residual Oil Upon	W91-10908 51
Behavior of the Fungicide MBAMT in Water.	Sampling of Underlying Ground Water.	
W91-11315 5A	W91-10793 5B	Geochemical Evolution in the Cambrian-Ordo
		vician Sandstone Aquifer, Eastern Wisconsin: 1
FUTURE PLANNING	Field Sampling of Residual Aviation Gasoline in	Major Ion and Radionuclide Distribution.
Modern Environmental Assessment Procedures	Sandy Soil.	W91-10953 21
for Enclosed Seas.	W91-10795 5A	Embadding and Bass and Mattin Test in the
W91-10564 6G	CATEG	Embedding and Response Matrix Techniques fo
	GATES	Maximizing Steady-State Ground-Water Extraction: Computational Comparison.
Water Management Issues for the Nineties.	In-Flow Vibrations of Gate Edges. W91-10724 8B	
W91-10807 6D	W91-10724 8B	11 /1-10934

### GEOCHEMISTRY

Throughflow and Solute Transport in an Isolated Sloping Soil Block in a Forested Catchment. W91-10993	Geohydrology and Simulation of Ground-Water Flow in the Mesilla Basin, Dona Ana County, New Mexico, and El Paso County, Texas. W91-11088	Ground-Water Flow and Stream-Aquifer Rela- tions in the Northern Coastal Plain of Georgia and Adjacent Parts of Alabama and South Caro- lina.
Heavy Metal Transport to the Great Lakes by		W91-11598 2F
Natural Ground-Water Discharge: An Initial Evaluation.	Hydrologic, Meteorological, and Unsaturated- Zone Moisture-Content Data, Franking Lake	GEOLOGIC FRACTURES
W91-11062 5B	Playa, Inyo County, California. W91-11089 2F	Municipal Ground Water from Ancient Crystal-
Geochemical Evolution of Ground Water in	Geohydrology and Water Quality of Kalamazoo	line Bedrock. W91-10822 2F
Smith Creek ValleyA Hydrologically Closed Basin in Central Nevada, U.S.A.	County, Michigan, 1986-88.	
W91-11392 2K	W91-11091 2F	Seismic Hazard at Narmada Sagar Dam. W91-10949 8E
Ground-Water Control of Evaporite Deposition. W91-11438 2K	Geohydrology and Simulation of Flow in the Chicot Aquifer System of Southwestern Louisi- ana.	Depth of Fractures and Active Ground-Water Flow in a Clayey Till Plain in Southwestern
Magnetite Formation During Microbial Dissimi-	W91-11100 2F	Ontario.
latory Iron Reduction. W91-11544 2J	Availability of Ground Water from Unconsoli-	W91-10959 2F
GEOGRAPHIC INFORMATION SYSTEMS	dated Deposits in the Mohawk River Basin, New York.	GEOLOGICAL DATA
Fast Algorithm for Automatically Computing	W91-11104 2F	Engineering Geology of Nearshore Areas off Richards Island, N.W.T.: A Comparison of
Strahler Stream Order. W91-10818 2J	Hydrogeology of the Valley-Fill Aquifer at	Stable and Actively Eroding Coastlines.
	Owego, Tioga County, New York.	W91-10944 2J
Planned Studies of Agrichemicals in Ground and Surface Water in the Mid-Continental	W91-11105 2F	GEOLOGICAL SURVEYS
United States.	Hydrology of the Floridan Aquifer System in East-Central Florida.	Hydrogeologic Inferences from Drillers' Logs and from Gravity and Resistivity Surveys in the
W91-11168 5B	W91-11113 2F	Amargosa Desert, Southern Nevada.
ATLAS*GRAPHICS: An Affordable Mapping	Hydrogeology of the Point Lookout Sandstone	W91-10996 5E
System. W91-11175 7C	in the San Juan Structural Basin, New Mexico,	Minnesota District, Water Resources Division:
Application of the DRASTIC Mapping System	Colorado, Arizona, and Utah. W91-11114 2F	Information and Technical Assistance. W91-11167 2F
for Evaluating Ground Water Pollution Poten-	Geostatistical Characteristics of the Borden Aq-	
tial in Ohio. W91-11178 5B	uifer.	GEOMAGNETIC STUDIES  Magnetite Formation During Microbial Dissimi-
GEOGRAPHY	W91-11234 2F	latory Iron Reduction.
Geographical and Pollenanalytical Research of	Response of Water Level in a Well to a Time Series of Atmospheric Loading Under Confined	W91-11544 2J
Lake Kleiner Barsch-See (Bez. Potsdam, GDR) (Geographische und Pollenanalytische Untersu-	Conditions.	GEOMORPHOLOGY
chungen des Kleinen Barsch-Sees) (Bez. Pots-	W91-11236 2F	Fast Algorithm for Automatically Computing Strahler Stream Order.
dam, DDR). W91-11514 2H	Diffusion in Fractal Porous Media. W91-11243 2F	W91-10818 2J
GEOHYDROLOGY		Visual Interpretation of a Landsat Mosaic of the
Geohydrologic Evaluation of Spring Sites at Social Circle, Georgia, December 5-8, 1988.	Hydrochemistry of a Groundwater-Seawater Mixing Zone, Nauru Island, Central Pacific Ocean.	Okavango Delta and Surrounding Area. W91-10879 2H
W91-10767 2F	W91-11297 2K	Engineering Geology of Nearshore Areas off
Ground-Water Flow and Solute Movement to Drain Laterals, Western San Joaquin Valley,	Studies of Springs in the Southern Part of the Valley of Mexico (Estudio Crenologico en la	Richards Island, N.W.T.: A Comparison of Stable and Actively Eroding Coastlines. W91-10944 2J
California. I. Geochemical Assessment. W91-10768 5B	Parte Meridional de la Cuenca de Mexico). W91-11352 2E	
Ground-Water Flow and Solute Movement to	Application of Uphole Data from Petroleum	Geomorphological Dispersion. W91-11232 2E
Drain Laterals, Western San Joaquin Valley,	Seismic Surveys to Groundwater Investigations,	
California. II. Quantitative Hydrologic Assess- ment.	Abu Dhabi (United Arab Emirates). W91-11399 7C	Morphology and Quantitative Analysis of Fluvi- al Erosion Systems in the Hydrological Network
W91-10769 5B		of the Basque Country Autonomous Region.
Character and Evolution of the Ground-Water	Aquifers in the Benin Formation (Miocene- Recent), Eastern Niger Delta, Nigeria: Lithos-	W91-11265 2J
Flow System in the Central Part of the Western San Joaquin Valley, California.	tratigraphy, Hydraulics, and Water Quality. W91-11443 2F	Dendrogeomorphic Approach to Estimating Slope Retreat, Maxey Flats, Kentucky.
W91-10772 2F	Geologic Framework of the Columbia Plateau	W91-11395 2D
Municipal Ground Water from Ancient Crystal- line Bedrock.	Aquifer System, Washington, Oregon, and Idaho.	Paleohydrologic Techniques Used to Define the Spatial Occurrence of Floods.
W91-10822 2F	W91-11571 2F	W91-11396 2E
Application of Ground-Penetrating-Radar Meth-	Hydrogeology, Water Quality, and Ground-	Dendrogeomorphic Approach to Measurement
ods in Hydrogeologic Studies. W91-10956 7B	Water Development Alternatives in the Lower Wood River Ground-Water Reservoir, Rhode	of Sedimentation in a Forested Wetland, Black Swamp, Arkansas.
Hydrogeologic Inferences from Drillers' Logs	Island. W91-11572 2F	W91-11397 2H
and from Gravity and Resistivity Surveys in the		GEONETS
Amargosa Desert, Southern Nevada. W91-10996 5E	Description of the Physical Environment and Coal-Mining History of West-Central Indiana,	Behavior of Double Geonet Drainage Systems.
Assessment of Hydrogeologic Conditions with	with Emphasis on Six Small Watersheds. W91-11576 2E	W91-11096 5A
Emphasis on Water Quality and Wastewater In-		GEOPHYSICAL METHODS
jection, Southwest Sarasota and West Charlotte Counties, Florida.	Hydrology of the Arbuckle Mountains Area, South-Central Oklahoma.	Application of Ground-Penetrating-Radar Meth- ods in Hydrogeologic Studies.
W91-11087 2F	W91-11590 2F	W91-10956 7B

7B

GEOPHYSICAL SURVEYS Delineation of a Discontinuous Aquitard with Vertical Electrical Soundings, San Bernardino	Situation of Water Supply in the New Lander of the Federal Republic of Germany. W91-11272 5F	Climatic Change and Future Agroclimatic Potential in Europe. W91-10970 2B
Valley, Southern California. W91-10960 5B	Methyl and Butyltin Compounds in Water and	Water Supply Implication of Climate Change in
Hydrogeologic Inferences from Drillers' Logs	Sediments of the Rhine River. W91-11335 5B	Western North American Basins. W91-11059 2B
and from Gravity and Resistivity Surveys in the Amargosa Desert, Southern Nevada.	Squall Line in Southern Germany: Kinematics	Simulated Hydrologic Effects of Climatic
W91-10996 5E	and Precipitation Formation as Deduced by Ad- vanced Polarimetric and Doppler Radar Meas-	Change in the Delaware River Basin. W91-11060 5C
GEOPHYSICS Geophysical and Chemical Investigations of	urements.	Great lakes Hydrological Impacts of 2xCO2 Cli-
Ground Water at Five Industrial or Waste-Disposal Sites in Logan Township, Gloucester	W91-11420 2B	mate Change. W91-11061 5C
County, New Jersey, 1983-87.	GIARDIA  Determining Giardiasis Prevalence by Examina-	Environmental Problems and Solutions: Green-
W91-11092 5B	tion of Sewage. W91-10646 5A	house Effect, Acid Rain, Pollution.
Application of Uphole Data from Petroleum Seismic Surveys to Groundwater Investigations,	Occurrence and Viability of Giardia spp. Cysts	W91-11066 5B
Abu Dhabi (United Arab Emirates). W91-11399 7C	in UK Waters. W91-10647 5B	Observational and Theoretical Studies of Green- house Climate Effects.
GEORGIA		W91-11067 5C
Update of Flood-Flow Characteristics of Nancy Creek at Georgia Highway 400 Extension Near	Wastewater and Giardia Cysts. W91-10648 5B	Challenge of Sustaining Productivity in the Face of CO2-Induced Change.
Atlanta, Georgia. W91-10762 2E	Distribution of Giardia Cysts in Wastewater.	W91-11073 5C
Geohydrologic Evaluation of Spring Sites at	W91-10649 5B	Approaches to the Simulation of Regional Cli- mate Change: A Review.
Social Circle, Georgia, December 5-8, 1988.	Package Water Plant Filters to 0.02 N.T.U. W91-11225 5F	W91-11427 5C
	GLACIAL LAKES	Interpretation of Hydrologic Effects of Climate Change in the Sacramento-San Joaquin River
Ground-Water Flow and Stream-Aquifer Rela- tions in the Northern Coastal Plain of Georgia and Adjacent Parts of Alabama and South Caro-	Periodic Drainage of Ice-Dammed Lakes as a Result of Variations in Glacier Velocity.	Basin, California. W91-11552 5C
lina. W91-11598 2F	W91-11348 2C	GLYCINE BETAINE
GEOSMIN	GLACIATION Geochemical Evidence Supporting T. C. Cham-	Protective Effect of Glycine Betaine on Survival of Escherichia coli Cells in Marine Environ-
Development of an Enzyme-Linked Immunosor-	berlin's Theory of Glaciation. W91-10790 2C	ments. W91-10637 5B
bent Assay for Geosmin. W91-10921 5F	Diatom Analysis, Late-Glacial and Post-Glacial	GLYPHOSATE
GEOSTATISTICS Use of 137Cs as a Tracer in an Erosion Study in South Limburg (The Netherlands) and the Influ-	Development of Lake Kleiner Barsch-See (GDR)—A Preliminary Note. W91-11517 2H	Liquid Chromatographic Determination of Gly- phosate and Aminomethylphosphonic Acid (AMPA) in Environmental Water: Collaborative
ence of Chernobyl Fallout.	GLACIERS	Study.
W91-11351 7B	Evidence of Chernobyl Fallout on a Temperate	W91-11261 5A GODAVARI RIVER
GEOTEXTILES Behavior of Double Geonet Drainage Systems.	Himalayan Glacier. W91-10950 5B	Heavy Metal Distribution in the Godvari River
W91-11096 5A	Periodic Drainage of Ice-Dammed Lakes as a	Basin. W91-11445 5B
GEOTHERMAL WASTES  Role of Biotechnology in the Treatment of Geo-	Result of Variations in Glacier Velocity. W91-11348 2C	GOVERNMENT INTERRELATIONS
thermal Residual Sludges. W91-10744 5D	Variability of Glacier Mass Balances in Western	So What. Findings and Recommendations from the Lake Levels Study.
GERMANY	North America.	W91-11037 6A
Coliform Bacteria in Drinking Water from South Bavaria: Identification by the API 20E-	W91-11391 2C	GOVERNMENT SUPPORTS  Limits of Government Responsibility.
System and Resistance Patterns.	GLACIOHYDROLOGY Periodic Drainage of Ice-Dammed Lakes as a	W91-11034 6E
W91-10627 5F Study of Campylobacter in Sewage, Sewage	Result of Variations in Glacier Velocity. W91-11348 2C	Strategic Issues in Watershed Development. W91-11564 4D
Study of Campylobacter in Sewage, Sewage Sludge and in River Water. W91-10634 5D	GLOBAL WARMING	GOVERNMENTAL INTERRELATIONS
Bdellovibrio sp.: A Predator under Groundwat-	Potential Impacts of Climate Change on the Great Lakes.	Interprovincial Water Management in Western Canada.
er Conditions. A Short Communication. W91-10676 5B	W91-10480 2H	W91-11040 6E
Pulsed Field Electrophoresis of Genomic Re-	Research on Clouds and Precipitation: Past, Present and Future, Part II.	Situation of Water Supply in the New Lander of the Federal Republic of Germany.
striction Fragments for the Detection of Noso-	W91-10481 3B	W91-11272 5F
comial Legionella pneumophila in Hospital Water Supplies.	Potential Effects of Global Warming on the Primary Productivity of a Subalpine Lake.	Regulation of Interbasin Transfers and Con-
W91-10836 5A	W91-10819 2H	sumptive Uses from the Great Lakes. W91-11384 6E
Stabilization of Sewage Sludge and Its Disinfec- tion According to Specific Requirements: Two- Stage Anaerobic/Aerobic Operating Tech-	Effects of Climate Change on Discharges and Snow Cover in Finland.	Resale of the Columbia River Treaty Down- stream Power Benefits: One Road from Here to
niques. W91-11141 5D	W91-10964 2C	There. W91-11386 6E
Aerobic-Thermophilic Methods for Disinfecting	Some Updated Statistical Assessments of the	Danube River Basin: Negotiating Settlements to
and Stabilizing Sludge. W91-11143 5D	Greenhouse Gases.	Transboundary Environmental Issues. W91-11387 5G

## **GRANULAR ACTIVATED CARBON**

GRANULAR ACTIVATED CARBON	1987-89 Drop in Great Lakes Water Levels,	GREAT LAKES/ST LAWRENCE RIVER BASIN
Home Water Treatment: Remediating Aldicarb Contamination in Suffolk County, New York.	Causes and Effect. W91-11023 2H	Fluctuating Water Levels in the Great Lakes-St. Lawrence River Basin: An Evaluation Frame-
W91-11189 5F	Provincial Guidelines to Great Lakes Shoreline	work for the Analysis of Potential Actions. W91-11026 6B
GRAPHICAL ANALYSIS Graphical Method for Determining the Coeffi-	Management Plans. W91-11024 6E	Fluctuating Great Lakes Water Levels: Progress
cient of Consolidation cv from a Flow-Pump Permeability Test.	Breaking the Incrementalist Trap: Achieving	and Opportunities. W91-11032 6A
W91-11393 7C	Unified Management of the Great Lakes Ecosys- tem.	
GRASSLANDS Hydrological Consequences of Artificial Drain-	W91-11025 6A	GREAT PLAINS Adoption of Water-Savings Practices by Irriga-
age of Grassland.	Fluctuating Water Levels in the Great Lakes-St.	tors in the High Plains. W91-10821 3F
W91-11347 2G	Lawrence River Basin: An Evaluation Frame- work for the Analysis of Potential Actions.	
GRAVITY DAMS Nonlinear Earthquake Response of Concrete	W91-11026 6B	GREAT SALT LAKE Hydrologic Characteristics of the Great Salt
Gravity Dam Systems. W91-10754 8F	Great Lakes Water Levels Management: Relax- ing the 'Policy Trap'.	Lake, Utah: 1847-1986. W91-11597 2H
	W91-11027 6A	GREECE
Seismic Fracture Analysis of Concrete Gravity Dams.	Regulation of Lake Ontario Levels.	Water Quality Assessment and Protection Meas-
W91-10787 8F	W91-11028 6A	ures of a Semi-Enclosed Coastal Area: The Bay of Thermaikos (NE Mediterranean Sea).
GRAVITY DRAINAGE	Successes and Challenges in Developing and	W91-10534 5G
Improved Analysis of Gravity Drainage Experi-	Implementing Remedial Action Plans to Restore Degraded Areas of the Great Lakes.	Sewage Treatment and Disposal Strategies in
ments for Estimating Unsaturated Soil Hydraulic Functions.	W91-11030 6A	Greece. W91-10598 5G
W91-11237 2G	Socio-Economic Considerations in Remedial	7-3
GRAVITY FILTERS	Action Planning for the Great Lakes-A Case	Contribution to the Study of the Recession
Comparison of Pressurized and Gravity Distri- bution Systems for Wastewater Treatment.	Study for Sustainable Development. W91-11031 6A	Curves of Karstic Springs: Examples from Greece (Contribution a l'Etude des Courses de
W91-10845 5D		Recession des Sources Karstiques: Exemples du
GRAZING	Fluctuating Great Lakes Water Levels: Progress and Opportunities.	Pays Hellenique). W91-10990 2F
Influence of Flooded Soil on Chemical Compo-	W91-11032 6A	W91-10990 2F
sition of Annual Ryegrass and Digestibility by	Fluctuating Water Levels: An Issue Manage-	Spatial Distribution of Rainfall in the Greater
Meadow Voles. W91-11536 2I	ment Approach.	Athens Area. W91-11416 2B
GREAT BARRIER REEF		Budgets of Selected Cations and Anions in Two
Status of Eutrophication in the Great Barrier Reef Lagoon.	Limits of Government Responsibility. W91-11034 6E	Forested Experimental Watersheds in Central Greece.
W91-10535 5B	Institutional Morass: Constraints and Opportuni-	W91-11550 4C
GREAT LAKES	ties for Issue Management.	GREEN BAY
Potential Impacts of Climate Change on the Great Lakes.	W91-11036 6A	Polychlorinated Biphenyls in Dated Sediment
W91-10480 2H	So What. Findings and Recommendations from the Lake Levels Study.	Cores from Green Bay and Lake Michigan. W91-10979 5B
Great Lakes Total Phosphorus Model: Post	W91-11037 6A	GREENHOUSE EFFECT
Audit and Regionalized Sensitivity Analysis. W91-10974 2H	Comparative Water Management: A Tale of	Effects of Climate Change on Discharges and Snow Cover in Finland.
Phosphorus from Internal Sources in the Lau-	Two Compacts. W91-11042 6A	W91-10964 2C
rentian Great Lakes, and the Concept of Thresh-		Some Updated Statistical Assessments of the
old External Load. W91-10982 5B	Water Diversion from the Great Lakes as a Dynamic Game.	Surface Temperature Response to Increased Greenhouse Gases.
Great Lakes Charter: Potential and Reality.	W91-11051 6B	W91-10969 2B
W91-11004 6E	Great lakes Hydrological Impacts of 2xCO2 Cli- mate Change.	Climatic Change and Future Agroclimatic Po-
Cooperative Data on Regional Water Use: The Great Lakes Regional Water Use Data Reposi-	W91-11061 5C	tential in Europe. W91-10970 2B
tory.	Heavy Metal Transport to the Great Lakes by	Environmental Problems and Solutions: Green-
W91-11010 6D	Natural Ground-Water Discharge: An Initial Evaluation.	house Effect, Acid Rain, Pollution.
Challenge of Implementing Ecosystem Manage- ment Plans in the Great Lakes Basin.	W91-11062 5B	W91-11066 5B
W91-11011 6B	Regulation of Interbasin Transfers and Con-	Observational and Theoretical Studies of Green-
Regional Approach to Drought Planning and	sumptive Uses from the Great Lakes. W91-11384 6E	house Climate Effects. W91-11067 5C
Management in the Great Lakes Basin.		Approaches to the Simulation of Regional Cli-
W91-11012 6A	GREAT LAKES BASIN Comparison of Mean Annual Runoff Estimates	mate Change: A Review.
Political Economic Model of International Pol-	in the Canadian Portion of the Great Lakes	W91-11427 5C
lution. W91-11016 5B	Basin. W91-11020 2E	GREENLAND
		Organic Carbon Accumulation in Baffin Bay
Applying Sustainable Development to the Great Lakes—Experience and Opportunities Under the	Statistical Characterization of Atrazine Residues in Southwestern Ontario Great Lakes Tributar-	and Paleoenvironment in High Northern Lati- tudes During the Past 20 m. y.
Boundary Waters Treaty.	in Southwestern Ontario Great Lakes Tributar- ies.	W91-10791 2J
W91-11019 6E	W91-11064 5B	
Great Lakes Levels and Flows Under Natural	GREAT LAKES CHARTER	GROUND PENETRATING RADAR Application of Ground-Penetrating-Radar Meth-
and Current Conditions.	Great Lakes Charter: Potential and Reality.	ods in Hydrogeologic Studies.
W91-11022 2H	W91-11004 6E	W91-10956 7B

7B

GROUNDWATER Nitrate Removal by Denitrification in Alluvial Ground Water: Role of a Former Channel.	Groundwater Depletion in India: Institutional Management Regimes. W91-11382 4B	Throughflow and Solute Transport in an Isolat- ed Sloping Soil Block in a Forested Catchment. W91-10993
W91-10909 5B	Hydrogeology, Water Quality, and Ground-	Environmental Isotope Study for Estimating
GROUNDWATER CHEMISTRY	Water Development Alternatives in the Lower Wood River Ground-Water Reservoir, Rhode	Leakage and Runoff of Ground Waters in the
Geochemical Evolution in the Cambrian-Ordo- vician Sandstone Aquifer, Eastern Wisconsin: 1.	Island.	Xi'an Area. W91-10994 2F
Major Ion and Radionuclide Distribution. W91-10953 2K	W91-11572 2F	Hydrogeologic Inferences from Drillers' Logs
	Evaluation of Site-Selection Criteria, Well Design, Monitoring Techniques, and Cost Anal-	and from Gravity and Resistivity Surveys in the
Tritium as an Indicator of Ground-Water Age in Central Wisconsin.	ysis for a Ground-Water Supply in Piedmont Crystalline Rocks, North Carolina.	Amargosa Desert, Southern Nevada. W91-10996 5E
W91-10958 2F	W91-11596 2F	Boundary Element and Particle Tracking Model
Hydrochemistry of a Groundwater-Seawater Mixing Zone, Nauru Island, Central Pacific	GROUNDWATER MOVEMENT Application of Microbial Tracers in Groundwat-	for Advective Transport in Zoned Aquifers. W91-10997 2F
Ocean. W91-11297 2K	er Studies. W91-10671 5B	Geohydrology and Simulation of Ground-Water
Geochemical Evolution of Ground Water in	Field Experiments with Microbiological Tracers	Flow in the Mesilla Basin, Dona Ana County, New Mexico, and El Paso County, Texas.
Smith Creek ValleyA Hydrologically Closed Basin in Central Nevada, U.S.A.	in a Pore Aquifer.	W91-11088 2F
W91-11392 2K	W91-10673 5B	Analysis of Ground-Water Flow in the A-Sand
Variation in the Acidity of Ground and Surface	Establishment of a Groundwater Research Data Center for Validation of Subsurface Flow and	Aquifer at Paramaribo, Suriname, South Amer- ica.
Waters in Northern Ireland.	Transport Models.	W91-11090 2F
W91-11407 2H	W91-10736 2F	Geohydrology and Simulation of Flow in the
GROUNDWATER DATING Tritium as an Indicator of Ground-Water Age in	Preconditioned Conjugate-Gradient 2 (PCG2), A Computer Program for Solving Ground-	Chicot Aquifer System of Southwestern Louisi- ana.
Central Wisconsin. W91-10958 2F	Water Flow Equations. W91-10764 7C	W91-11100 2F
	Ground-Water Flow and Solute Movement to	Calibration of a Texture-Based Model of a
GROUNDWATER DEPLETION Adoption of Water-Savings Practices by Irriga-	Drain Laterals, Western San Joaquin Valley, California. I. Geochemical Assessment.	Ground-Water Flow System, Western San Joa- quin Valley, California.
tors in the High Plains. W91-10821 3F	W91-10768 5B	W91-11101 5B
Groundwater Depletion in India: Institutional	Ground-Water Flow and Solute Movement to	Availability of Ground Water from Unconsoli- dated Deposits in the Mohawk River Basin,
Management Regimes. W91-11382 4B	Drain Laterals, Western San Joaquin Valley, California. II. Quantitative Hydrologic Assess-	New York. W91-11104 2F
GROUNDWATER DISCHARGE	ment. W91-10769 5B	Hydrology of the Floridan Aquifer System in
Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial	Character and Evolution of the Ground-Water	East-Central Florida. W91-11113 2F
Evaluation. W91-11062 5B	Flow System in the Central Part of the Western San Joaquin Valley, California.	Response of Water Level in a Well to a Time
GROUNDWATER LEVEL	W91-10772 2F Groundwater Flow and the Metal Content of	Series of Atmospheric Loading Under Confined Conditions.
Response of Water Level in a Well to a Time	Peat.	W91-11236 2F
Series of Atmospheric Loading Under Confined Conditions.	W91-10902 2F	Application of a Multiprocess Nonequilibrium
W91-11236 2F	Hydrogeochemical Processes Controlling Sub- surface Transport from an Upper Subcatchment	Sorption Model to Solute Transport in a Strati- fied Porous Medium.
GROUNDWATER MANAGEMENT Geohydrologic Evaluation of Spring Sites at	of Walker Branch Watershed During Storm Events. 1. Hydrologic Transport Processes.	W91-11239 5B
Social Circle, Georgia, December 5-8, 1988.	W91-10907 5B	Diffusion in Fractal Porous Media. W91-11243 2F
W91-10767 2F	Hydrogeochemical Processes Controlling Sub-	
Groundwater Management Model for Salt Lake County, Utah with Some Water Rights and	surface Transport from an Upper Subcatchment of Walker Branch Watershed During Storm	Studies of Springs in the Southern Part of the Valley of Mexico (Estudio Crenologico en la
Water Quality Considerations.	Events. 2. Solute Transport Processes.	Parte Meridional de la Cuenca de Mexico).
W91-10911 4B	W91-10908 5B	W91-11352 2E
Embedding and Response Matrix Techniques for Maximizing Steady-State Ground-Water Extrac-	Computation of Average Seasonal Groundwater Flows in Phreatic Aquifer-River System. W91-10910 2F	Graphical Method for Determining the Coeffi- cient of Consolidation cv from a Flow-Pump
tion; Computational Comparison. W91-10954 2F		Permeability Test. W91-11393 7C
	Self-Affine Scaling and Subsurface Response to Snowmelt in Steep Terrain.	Ground-Water Control of Evaporite Deposition.
Evaluation of Three Scenarios of Ground-Water Withdrawal from the Mississippi River Alluvial	W91-10912 2G	W91-11438 2K
Aquifer in Northwestern Mississippi. W91-11106 4B	Embedding and Response Matrix Techniques for Maximizing Steady-State Ground-Water Extrac- tion; Computational Comparison.	New Approach to Tracer Transport Analysis: From Fracture Systems to Strongly Heterogene-
Northwest Kansas Groundwater Management District No. 4. An Abandoned Well Program.	W91-10954 2F	ous Porous Media. W91-11554 2F
W91-11188 5G	Delineation of Traveltime-Related Capture	Piping and Pseudokarst in Drylands.
W 71-11100		
Central Platte Natural Resources District's	Areas of Wells Using Analytical Flow Models and Particle-Tracking Analysis.	W91-11561 2F
Central Platte Natural Resources District's Groundwater Management Program.	Areas of Wells Using Analytical Flow Models	
Central Platte Natural Resources District's	Areas of Wells Using Analytical Flow Models and Particle-Tracking Analysis.	W91-11561 2F
Central Platte Natural Resources District's Groundwater Management Program. W91-11190 5G	Areas of Wells Using Analytical Flow Models and Particle-Tracking Analysis. W91-10957 2F Depth of Fractures and Active Ground-Water	W91-11561 2F Ground-Water Flow and Stream-Aquifer Rela- tions in the Northern Coastal Plain of Georgia

### **GROUNDWATER POLLUTION**

ROUNDWATER POLLUTION	Sorption Phenomena in Subsurface Systems:	Groundwater Contamination By Anthropogenic
Ground Water: How Contaminated.	Concepts, Models, and Effects on Contaminant	Organic Compounds From Waste Disposal
W91-10484 5G	Fate and Transport. W91-10882 5B	Sites: Transformations and Behavior. W91-11378 5B
Aquifer Restoration: Which Method.	Prospecting for Zones of Contaminated Ground-	Minorthan and Tourtment of a Dame Assurem
W91-10486 5G	Water Discharge to Streams Using Bottom-Sedi-	Migration and Treatment of a Dense Aqueous Contaminant Source and Plume.
Bdellovibrio sp.: A Predator under Groundwater Conditions. A Short Communication.	ment Gas Bubbles. W91-10951 5B	W91-11380 5G
W91-10676 5B	Delineation of a Discontinuous Aquitard with	Ground Water Contamination from Agricultural
Superfund Record of Decision: Commencement	Vertical Electrical Soundings, San Bernardino Valley, Southern California.	Sources: Implications for Voluntary Policy Adherence from Iowa and Virginia Farmer's Atti-
Bay/S. Tacoma, WA. W91-10711 5G	W91-10960 5B	tudes. W91-11437 5G
Sweetend Board of Desiries, Chamtenies	Comparative Physico-Chemical Analysis of	A If i- sh- Di- Fi- Off
Superfund Record of Decision: Chemtronics (Amendment), NC.	Drinking, Ground and Industrial Waste Water of Jodhpur.	Aquifers in the Benin Formation (Miocene- Recent), Eastern Niger Delta, Nigeria: Lithos-
W91-10713 5G	W91-11083 5B	tratigraphy, Hydraulics, and Water Quality. W91-11443
Superfund Record of Decision: IBM (San Jose), CA.	Geophysical and Chemical Investigations of	Deforestation and Leaching of Nitrogen as Ni-
W91-10715 5G	Ground Water at Five Industrial or Waste-Dis- posal Sites in Logan Township, Gloucester	trates into Underground Water in Intertropical
Fiscal Year 1988 Supported Liquid Membrane	County, New Jersey, 1983-87.	Zones: The Example of Cote d'Ivoire. W91-11446 2F
Development Report. W91-10727 5G	W91-11092 5B	Sources and Extent of Groundwater Contamina-
	Calibration of a Texture-Based Model of a Ground-Water Flow System, Western San Joa-	sources and Extent of Groundwater Contamina- tion.
Remedial Investigation of the High Explosives Burn Pit Facility, Building 829 Complex, Law-	quin Valley, California.	W91-11546 5B
rence Livermore National Laboratory Site 300.	W91-11101 5B	Description of the Physical Environment and
W91-10731 5B	Application of the DRASTIC Mapping System	Coal-Mining History of West-Central Indiana, with Emphasis on Six Small Watersheds.
Health Risk Assessment of Toluene in California	for Evaluating Ground Water Pollution Poten- tial in Ohio.	W91-11576 2E
Drinking Water. W91-10741 5C	W91-11178 5B	GROUNDWATER QUALITY
	Wellhead Protection in Massachusetts: Protect-	Installation of the Westbay Multiport Ground-
Superfund Record of Decision: Reich Farms, NJ.	ing Public Water Supplies from Pesticide Impacts.	Water Sampling System in Well 699-43-42K Near The 216-B-3 Pond.
W91-10743 5G	W91-11182 5G	W91-10720 7B
Soil Vapor Survey at the LLNL Site 300 Gener-	Wisconsin's Risk Assessment Based Numerical	Status of Ground Water in the 1100 Area.
al Services Area, Adjacent Portions of the Con- nolly and Gallo Ranches and the Site 300 Land-	Groundwater Standards Program. W91-11183 5G	W91-10732 5B
fill Pit 6 Area.	W31-11163	Superfund Record of Decision: South Valley/
W91-10747 5B	Innovative Subsurface Sewage Management: A Program to Protect Idaho's Rathdrum Prairie	Edmunds Street, NM. W91-10758 5G
Superfund Record of Decision: Kin-Buc Land-	Aquifer.	
fill, NJ. W91-10755 5G	W91-11186 5G	Effects of Land-Use Buffer Size on Spearman's Partial Correlations of Land Use and Shallow
	Northwest Kansas Groundwater Management District No. 4. An Abandoned Well Program.	Ground-Water Quality.
Superfund Record of Decision: Celanese Fibers Operations, NC.	W91-11188 5G	W91-10761 4C
W91-10759 5G	Central Platte Natural Resources District's	Relationship of Regional Water Quality to Aqui-
Impact of Recharge Through Residual Oil Upon	Groundwater Management Program.	fer Thermal Energy Storage. W91-11082 5C
Sampling of Underlying Ground Water.	W91-11190 5G	
W91-10793 5B	Developing a Groundwater Training Program	Assessment of Hydrogeologic Conditions with Emphasis on Water Quality and Wastewater In-
Cone Penetrometer Tests and HydroPunch Sampling: A Screening Technique for Plume	for Pesticide Users. W91-11199 5G	jection, Southwest Sarasota and West Charlotte Counties, Florida.
Definition.	Theoretical Study of the Significance of Nana	W91-11087 2F
W91-10794 5A	Theoretical Study of the Significance of None- quilibrium Dissolution of Nonaqueous Phase	
Method for Assessing Residual NAPL Based on	Liquids in Subsurface Systems. W91-11228 5B	Geohydrology and Water Quality of Kalamazoo County, Michigan, 1986-88.
Organic Chemical Concentrations in Soil Sam- ples.		W91-11091 2F
W91-10797 5A	Optimal Data Acquisition Strategy for the De- velopment of a Transport Model for Ground-	Hydrogeology of the Point Lookout Sandstone
Computer Modeling of Scale Formation During	water Remediation.	in the San Juan Structural Basin, New Mexico, Colorado, Arizona, and Utah.
Treatment of Ground Water in Air Strippers.	W91-11238 5G	W91-11114 2F
W91-10798 5G	Strategy for Pesticide Control in Ground Water	Agrichemicals and Groundwater Protection:
Utility of Multiple-Completion Monitoring	and Drinking Water. W91-11312 5A	Resources and Strategies for State and Local
Wells for Describing a Solvent Plume. W91-10800 7A		Management.
	Solid-Phase Extraction for Multi-Residue Analysis of Some Triazole and Pyrimidine Pesticides	W91-11162 5G
Occurrence of Appendix IX Organic Constitu- ents in Disposal Site Ground Water.	in Water. W91-11313 5A	Agrichemicals and Ground Water: Assumptions about Farmer Information Processes.
W91-10801 5B		W91-11163 6B
Dispersal Dynamics of Groundwater Bacteria.	Stimulation of the Reductive Dechlorination of Tetrachloroethene in Anaerobic Aquifer Micro-	Communicating with Farmers: Providing Useful
W91-10843 5B	cosms by the Addition of Toluene.	and Reliable Sources of Information.
Rhine Rift Valley Groundwater-River Interac-	W91-11344 5B	W91-11164 5G
tions: Evolution of their Susceptibility to Pollu-	Application of Supported Liquid Membranes for	Emerging Issues at the Intersection of Agricul-
tion. W91-10849 5B	Removal of Uranium From Groundwater. W91-11370 5G	tural and Environmental Policy. W91-11165 5G

Overview of U.S. Geological Survey Water-	Municipal Ground Water from Ancient Crystal-	GROWTH
Resources Information Programs. W91-11166 10D	line Bedrock. W91-10822 2F	Comparative Study and Mathematical Modeling of Temperature, Light and Growth of Three
		Microalgae Potentially Useful for Wastewater
Wellhead Protection-Information and Re-	Hydrologic, Meteorological, and Unsaturated-	Treatment.
sources. W91-11172 5G	Zone Moisture-Content Data, Franking Lake Playa, Inyo County, California.	W91-10937 5D
	W91-11089 2F	Distribution, Habitat Use, and Growth of Age-0
Wellhead Protection in Massachusetts: Protect- ing Public Water Supplies from Pesticide Im-	Availability of Ground Water from Unconsoli-	Colorado Squawfish in the Green River Basin,
pacts.	dated Deposits in the Mohawk River Basin,	Colorado and Utah.
W91-11182 5G	New York.	W91-11534 2H
Geochemical Evolution of Ground Water in	W91-11104 2F	GULF OF LIONS
Smith Creek ValleyA Hydrologically Closed	Hydrogeology of the Valley-Fill Aquifer at	Fluxes and Transport of Anthropogenic and Natural Polycyclic Aromatic Hydrocarbons in
Basin in Central Nevada, U.S.A.	Owego, Tioga County, New York. W91-11105 2F	the Western Mediterranean Sea.
W91-11392 2K	W91-11105 2F	W91-10841 5B
Ground Water Contamination from Agricultural	Evaluation of Three Scenarios of Ground-Water	GULF OF THAILAND
Sources: Implications for Voluntary Policy Ad- herence from Iowa and Virginia Farmer's Atti-	Withdrawal from the Mississippi River Alluvial Aquifer in Northwestern Mississippi.	Long Term Ecological Changes in the Gulf of
tudes.	W91-11106 4B	Thailand.
W91-11437 5G	Hydrology of the Floridan Aquifer System in	W91-10551 5B
Aquifers in the Benin Formation (Miocene-	East-Central Florida.	GURPUR RIVER BASIN
Recent), Eastern Niger Delta, Nigeria: Lithos-	W91-11113 2F	Studies on Assessment of Water Balance and Its
tratigraphy, Hydraulics, and Water Quality.	Hydrogeology of the Point Lookout Sandstone	Quality in Gurpur River Basin, Karnataka State, India.
W91-11443 2F	in the San Juan Structural Basin, New Mexico,	W91-11065 5B
Sources and Extent of Groundwater Contamina-	Colorado, Arizona, and Utah.	
tion.	W91-11114 2F	Review of Fisheries Habitat Improvement
W91-11546 5B	Funding Groundwater Protection Programs:	Projects in Warmwater Streams, with Recom-
Hydrogeology, Water Quality, and Ground-	Iowa's Groundwater Protection Fund. W91-11179 5G	mendations for Wisconsin.
Water Development Alternatives in the Lower	W91-11179 5G	W91-11591 2H
Wood River Ground-Water Reservoir, Rhode Island.	Application of Uphole Data from Petroleum	HABITAT RESTORATION
W91-11572 2F	Seismic Surveys to Groundwater Investigations, Abu Dhabi (United Arab Emirates).	Strategies for Restoring and Developing Fish
Description of the Physical Environment and	W91-11399 7C	Habitats in the Strait of Georgia: Puget Sound
Coal-Mining History of West-Central Indiana,	Carlaria Promount of the Columbia Platers	Inland Sea, Northeast Pacific Ocean. W91-10568 5G
with Emphasis on Six Small Watersheds.	Geologic Framework of the Columbia Plateau Aquifer System, Washington, Oregon, and	
W91-11576 2E	Idaho.	Review of Fisheries Habitat Improvement Projects in Warmwater Streams, with Recom-
Evaluation of Site-Selection Criteria, Well	W91-11571 2F	mendations for Wisconsin.
Design, Monitoring Techniques, and Cost Anal-	Hydrology of the Arbuckle Mountains Area,	W91-11591 2H
ysis for a Ground-Water Supply in Piedmont Crystalline Rocks, North Carolina.	South-Central Oklahoma.	HAIL
W91-11596 2F	W91-11590 2F	Use of Single-Doppler Radar for Estimating
	Evaluation of Site-Selection Criteria, Well	Maximum Hailstone Size.
GROUNDWATER RECHARGE Evidence for Dilution of Deep, Confined	Design, Monitoring Techniques, and Cost Anal-	W91-10858 2B
Ground Water by Vertical Recharge of Isotopi-	ysis for a Ground-Water Supply in Piedmont Crystalline Rocks, North Carolina.	HALIDES
cally Heavy Pleistocene Water.	W91-11596 2F	Factors Affecting the Removal and Discharge
W91-10792 2F	GROUNDWATER TRANSPORT	of Organic Chlorine Compounds at Activated Sludge Treatment Plants.
Impact of Recharge Through Residual Oil Upon	Application of Microbial Tracers in Groundwat-	W91-11498 5D
Sampling of Underlying Ground Water. W91-10793 5B	er Studies.	
	W91-10671 5B	HALOGENATED ORGANIC COMPOUNDS  Analysis of Halogenated Acetic Acids in Dutch
Computation of Average Seasonal Groundwater	Behaviour of Pathogenic Bacteria, Phages and	Drinking Water.
Flows in Phreatic Aquifer-River System. W91-10910 2F	Viruses in Groundwater During Transport and Adsorption.	W91-10938 5F
The second secon	Adsorption. W91-10672 5B	Continuous Flow Thin-Layer Headspace
Effect of Land Development on Groundwater Recharge Determined from Non-Steady Chlo-		(TLHS) Analysis. I. Conductometric Determi-
ride Profiles.	Field Experiments with Microbiological Tracers in a Pore Aquifer.	nation of Volatile Organic Halogens (VOX) in
W91-10991 4C	W91-10673 5B	Tap Water. W91-11256 5A
Environmental Isotope Study for Estimating	Towns of Missessins in the Hades	W91-11230
Leakage and Runoff of Ground Waters in the	Transport of Microorganisms in the Under- ground: Processes, Experiments and Simulation	HANDBOOKS
Xi'an Area.	Models.	Levels at Streamflow Gaging Stations. W91-11586 7E
W91-10994 2F	W91-10674 5B	
Innovative Subsurface Sewage Management: A	Boundary Element and Particle Tracking Model	HANFORD
Program to Protect Idaho's Rathdrum Prairie	for Advective Transport in Zoned Aquifers.	Installation of the Westbay Multiport Ground- Water Sampling System in Well 699-43-42K
Aquifer. W91-11186 5G	W91-10997 2F	Near The 216-B-3 Pond.
	GROUNDWATER WITHDRAWAL	W91-10720 71
Potential for Aquifer Recharge in Illinois (Ap-	Evaluation of Three Scenarios of Ground-Water	HANFORD SITE
propriate Recharge Areas). W91-11580 7C	Withdrawal from the Mississippi River Alluvial Aquifer in Northwestern Mississippi.	Status of Ground Water in the 1100 Area.
	W91-11106 4B	W91-10732 5I
GROUNDWATER RESOURCES Character and Evolution of the Ground-Water	GROUNDWATER YIELD	HANFORD SITE PROCESS CONTROL
Flow System in the Central Part of the Western	Geohydrologic Evaluation of Spring Sites at	Process Internal Measures to Reduce Pulp Mil
San Joaquin Valley, California.	Social Circle, Georgia, December 5-8, 1988.	Pollution Load.
W91-10772 2F	W91-10767 2F	W91-11473 50

### HARBORS

HARBORS Summary of Ports and Marine Environment Im-	Characterization and Simulation of Rainfall- Runoff Relations for Headwater Basins in West-	Extraction of Heavy Metals from Sludges and Muds by Magnetic Ion-Exchange.
provement Work and Example of Latest Meas-	ern King and Snohomish Counties, Washington.	W91-11145 5D
ures in Seto Inland Sea. W91-10545 5G	W91-11592 2A	Heavy Metal Speciation in Sewage Sludge Fol-
HAWAII	HEADWATERS HYDROLOGY Streamflow Generation in a Headwater Basin on	lowing a Phyto-Dewatering Treatment. W91-11147 5D
Three-Dimensional Simulation of Airflow and	the Precambrian Shield.	
Orographic Rain Over the Island of Hawaii. W91-10517 2B	W91-11349 2E	Existing Conditions for Agricultural Utilization of Sewage Sludge Compost in Japan.
Microclimatological Investigations in the Tropi-	HEAT BALANCE Multispectral Satellite Data in the Context of	W91-11152 5E
cal Alpine Scrub of Maui, Hawaii: Evidence for a Drought-Induced Alpine Timberline.	Land Surface Heat Balance. W91-11428 7B	New Developments in Sampling Sludge Treated Soils.
W91-10878 2I	HEAT STORAGE	W91-11158 5A
HAZARD ASSESSMENT	Relationship of Regional Water Quality to Aqui-	Chemical Properties of Sewage Sludges Pro-
Application of a Hazard Assessment Research	fer Thermal Energy Storage.	duced in the Valencian Area (Spain).
Strategy to the Ocean Disposal of a Dredged Material: Overview.	W91-11082 5C	W91-11159 5A
W91-10740 5E	HEAT TREATMENT Sludge Management by Thermal Conversion to	Selective Concentration of Lead(II) Chloride Complex With Liquid Anion-Exchange Mem-
Ecotoxicological Effects Assessment: A Com-	Fuels. W91-10706 5D	branes.
parison of Several Extrapolation Procedures. W91-10830 5A		W91-11247 5D
	HEAVY METALS Heavy Metal Pollution in Sediment from the	Distribution and Migration of Heavy Metals in
Initial Evaluation of Developmental Malforma- tion as an End Point in Mixture Toxicity Hazard	Seto Inland Sea, Japan.	the Environment of the Altai Mountains in Con- nection with Ecological Substantiation of the
Assessment for Aquatic Vertebrates.	W91-10537 5B	Katun Hydroelectric Station Project.
W91-10832 5C	Heavy Metals Contamination in the Polish Zone	W91-11292 5B
Standard Test Fish for India and the Neighbor-	of Southern Baltic.	Toxicity of Metals to a Freshwater Tubificid
ing Countries.	W91-10597 5B	Worm, Tubifex tubifex (Muller).
W91-11300 5A	Species and Genera of Enterobacteriaceae in	W91-11303 5C
HAZARDOUS MATERIALS	River Neckar and After River Bank Filtration	Assessment of Mercury Toxicity by the Changes
AgriSource: The Information System for Crop	and Their Resistance Patterns to Antibiotics and Heavy Metal Salts.	in Oxygen Consumption and Ion Levels in the
Technology. W91-11196 10D	W91-10675 5B	Freshwater Snail, Pila globosa, and the Mussel, Lamellidens marginalis.
Developing a Groundwater Training Program	Superfund Record of Decision: Pesses Chemical,	W91-11304 5C
for Pesticide Users.	TX.	Removal of Heavy Metals and Other Cations
W91-11199 5G	W91-10718 5G	From Wastewater Using Zeolites.
HAZARDOUS WASTE DISPOSAL	Biochemical and Histochemical Observations on	W91-11369 5D
Long Climb to Remediation. W91-10483 5G	Effects of Low-Level Metal Load (Lead, Cad- mium) in Different Organ Systems of the Fresh- water Crayfish, Astacus astacus L. (Crustacea:	Treatment of Waste Water From Wet Lime(Stone) Flue Gas Desulfurization Plants
Returnable Pesticide Containers: Maine's Depos-	Decapoda).	With Aid of Crossflow Microfiltration.
it and Collection System.	W91-10827 5B	W91-11371 5D
W91-11191 5G	Behavior of Heavy Metals in a Mud Flat of the	Low Cost Flow Injection Analysis for Cadmium
Oregon Pesticide Container Initiative.	Scheldt Estuary, Belgium.	Using 2-(2-benzothiazolylazo) -4,5-Dimethyl- phenol.
W91-11192 5E	W91-10872 5B	W91-11379 5A
Minnesota Waste Pesticide Collection Pilot	Effect of Three Primary Treatment Sewage	Trace Element Distribution in Surficial Sedi-
Project. W91-11193 5E	Outfalls on Metal Concentrations in the Fish Cheilodactylus fuscus Collected Along the	ments of the Northern Tyrrhenian Sea: Contri-
II.A. Parial Water Manager	Coast of Sydney, Australia.	bution to Heavy-Metal Pollution Assessment. W91-11444 5A
Urban Pesticide Waste Management: Strategies for Education and Collection.	W91-10873 5B	
W91-11194 5E	Patella vulgata, Mytilus minimus and Hyale pre-	Heavy Metal Distribution in the Godvari River Basin.
Pesticide Rinseate Management Plan.	vosti as Bioindicators for Pb and Se Enrichment in Alexandria Coastal Waters.	W91-11445 5E
W91-11195 5G	W91-10875 5A	
Maryland's Train-The-Trainer Program House-	Effects of Copper and Tributyltin on Stress Pro-	Lead Sorption in Calcareous Soils. W91-11453 5E
hold Hazardous Waste. W91-11200 5G	tein Abundance in the Rotifer Brachionus plica- tilis.	Studies on the Effects of Some Organic Pollut-
	W91-10900 5C	ants on the Heavy Metal Transport in an Indian
HAZARDOUS WASTES Treatability of Hazardous Chemicals in Soils:	Remobilization of Cu from Marine Particulate	Soil. W91-11457 5C
Volatile and Semivolatile Organics. W91-10712 5B	Organic Matter and from Sewage. W91-10923 5B	HEPATITIS A VIRUS
Superfined Bassed of Davisian Chambersian	Distribution of Dissolved Codesium Lond and	Concentration of Hepatitis A Virus in Environ- mental Samples.
Superfund Record of Decision: Chemtronics (Amendment), NC.	Distribution of Dissolved Cadmium, Lead and Copper in the Bristol Channel and the Outer	W91-10658 5A
W91-10713 5G	Severn Estuary.	
Occurrence of Appendix IX Organic Constitu-	W91-10925 5B	HERBICIDES  Atrazine Hazards to Fish, Wildlife, and Inverte
ents in Disposal Site Ground Water.	Heavy Metal Transport to the Great Lakes by	brates: A Synoptic Review.
W91-10801 5B	Natural Ground-Water Discharge: An Initial	W91-10709 50
HEADWATERS	Evaluation. W91-11062 5B	Use of Non-Persistent Herbicides, Glyphosate
Impact of a Pulse Application of Permethrin on		and 2,4-D Amine, to Control Riparian Stands of
the Macroinvertebrate Community of a Head- water Stream.	Removal of Heavy Metals from Sewage Sludge: State of the Art and Perspectives.	Japanese Knotweed (Reynoutria japonica Houtt).
W01-11456 SC	W01-11124 SD	W01-10852 AA

Determination of Chlorinated Phenoxy A and Ester Herbicides in Soil and Water	by	Road Salting Impacts in Massachusetts. W91-11053 4C	Water and Human Health. W91-11211 5F
Liquid Chromatography Particle Beam M Spectrometry and Ultraviolet Absorption Sp		HIMALAYAN MOUNTAINS	Cryptosporidiosis and Water Supply: A Brief
trophotometry.		Exporting Himalayan Floods.	Review, with Special Reference to the Report of
	5A	W91-11014 2E	the Badenoch Committee.
Liquid Chromatographic Determination of G	21	HIMALAYAS	W91-11271 5F
phosate and Aminomethylphosphonic A		Evidence of Chernobyl Fallout on a Temperate	HUMAN PATHOGENS
(AMPA) in Environmental Water: Collaborat		Himalayan Glacier. W91-10950 5B	Thames Water's Experiences with Cryptospori-
Study.		1171-10750	dium.
W91-11261	5A	HIROSHIMA BAY	W91-10617 5C
Development of an Enzyme Immunoassay	for	Eutrophication in Hiroshima Bay. W91-10536 5B	Improvement of the Quality of Sewage Sludge:
the Determination of Metazachlor.			Microbiological Aspects.
W91-11295	5A	HISTORY	W91-11125 5D
Determination of Herbicide Residues in Soi	il in	Milk River: Historical Transitions in an Interna- tional Waterway.	HUMIC SUBSTANCES
the Presence of Persistent Organochlorine Inc	sec-	W91-11039 6E	Removal of Humic Substances and Algae by
ticides.		Dat Daniel and Date of Water Daniel	Dissolved Air Flotation.
W91-11310	5A	Past, Present, and Future of Water Resources Management In the United States.	W91-10751 5F
Analysis of 10 Selected Herbicides in Wa	iter.	W91-11207 4A	Humic Substances in Acid Surface Waters;
W91-11311	5A	Post Possest and Posters of Water No. and	Modelling Aluminium Binding, Contribution to
Simazine Concentrations in a Stream Drain	nino	Past, Present, and Future of Water Use and Management.	Ionic Charge-Balance, and Control of pH.
an Agricultural Catchment.		W91-11209 4A	W91-10933 5C
W91-11364	4C		Algicidal and Chemical Effect of u.vRadiation
Aqueous Photolysis of Napropamide.		HONEY CREEK BASIN Analysis of Alternative Modifications for Re-	of Water Containing Humic Substances.
W91-11376	5B	ducing Backwater Flooding at the Honey Creek	W91-10941 5F
		Coal Strip Mine Reclamation Site in Henry	Sulfur Enrichment of Humic Substances in a
Microbial Dechlorination of the Herbicide : tolachlor.	Ме-	County, Missouri.	Delaware Salt Marsh Sediment Core.
W91-11377	5B	W91-11595 2E	W91-11258 2L
		HONG KONG	Multicomponent Kinetic Analysis of Iron Speci-
Effects of Chlornitrofen, a Herbicide, on Re		Hong Kong: Can the Dragon Clean its Nest.	ation in Humic Lake Tjeukemeer: Comparison
duction of Brachionus urceolaris (Rotato Through Water and Food (Chlorella).	oria)	W91-11439 5G	of Fulvic Acid from the Drainage Basin and
W91-11458	5C	HOSPITALS	Lake Water Samples.
		Preliminary Data Summary for the Hospitals	W91-11339 2H
HETEROGENEITY	aunia.	Point Source Category. W91-10738 5B	High-Performance Liquid Chromatographic
New Approach to Tracer Transport Anal From Fracture Systems to Strongly Heterog		W91-10/38	Study on Oxidation Products of Lignin and
ous Porous Media.	,00	HOT SPRINGS	Humic Substances.
W91-11554	2F	Characterization of Radioactivity in Hot Springs	W91-11513 5A
HIGH PERFORMANCE LIQUID		National Park, Arkansas. W91-10846 2K	HUNGARY
CHROMATOGRAPHY			Flood Forecasts on Transboundary Rivers in
Sensitive High-Performance Liquid Chrom		Removal of Biota from Inter-Basin Transfer	Hungary with Parallels in Canada. W91-11015 4A
graphic Analysis for Toxicological Studies	with	Water.	W91-11015
Carbaryl. W91-10920	5A	W91-11017 5F	
		HUDSON RIVER ESTUARY	Barrage System.
Flow-Rate Variated HPLC-/EC-Determina	ation	Mechanisms of Resistance to Polychlorinated	W91-11217 6G
of Phenols. W91-11257	5A	Biphenyls (PCB) in Two Species of Marine Dia-	
W31-11237	34	toms.	Sensitivity Studies of Tropical Storm Genesis
Direct Aqueous Injection-Liquid Chromato		W91-11562 5C	Using a Numerical Model. W91-11421 2E
phy With Post-Column Derivatization for termination of N-Methylcarbamoyloximes		HUMAN DISEASES	W91-11421 21
N-Methylcarbamates in Finished Drin	king	Health Risk Assessment of Water Contaminants	
Water: Collaborative Study.		Using Baseline Data of Cancer Incidence in Dif-	W91-11422 2E
W91-11260	5A	ferent Water Supply Areas. W91-10614 5F	HYDRAULIC CONDUCTIVITY
High-Performance Liquid Chromatogra	nhic		Comparison of Measured and Estimated Unsatu
Study on Oxidation Products of Lignin		Waterborne Disease Outbreak.	rated Hydraulic Conductivities During Snow
Humic Substances.		W91-10615 5C	W01 10004 3C
W91-11513	5A	Causes of Waterborne Outbreaks in the United	W91-10904
HIGHWAY EFFECTS		States.	Geostatistical Characteristics of the Borden Aq
Hydrocarbons in Urban Runoff: Their Cont	ribu-	W91-10616 5E	unet.
tion to the Wastewaters.		Prospective Epidemiological Study of Drinking	W91-11234 2F
W91-10885	5B	Water Related Gastrointestinal Illnesses. W91-10618 5E	Improved Analysis of Gravity Drainage Experi
HIGHWAY ICING			Transform Estimating Unsaturated Sou riversum
Road Salting Impacts in Massachusetts.	400	Determining Giardiasis Prevalence by Examina-	Functions. W91-11237 20
W91-11053	4C	tion of Sewage. W91-10646 5A	
HIGHWAYS			Effect of Low Salinity Water on Salt Displace
Dallas' Flood Caverns.	0.4	Review of the Epidemiology and Diagnosis of	ment in Two Soils. W91-11433
W91-10493	8A	Waterborne Viral Infections. W91-10651 5E	
Update of Flood-Flow Characteristics of N			HYDRAULIC DESIGN
Creek at Georgia Highway 400 Extension	Near	Occurrence of V. cholerae 0:1 Non-Toxigenic in	Scour at Cantilevered Pipe Outlets, Plunge, Poo Energy Dissipator Design Criteria.
Atlanta, Georgia. W91-10762	2E	Wastewaters from Sao Paulo, Brazil. W91-10685 5D	

## HYDRAULIC DESIGN

Analysis of Large Scale Water Distribution Sys- tems.	Flow Through Gated Conduits at Partial and Full Gate Openings.	Dams and Sustainable Development in Brazilian Amazonia.
W91-10983 5F	W91-11276 8C	W91-11216 8C
IYDRAULIC ENGINEERING Analysis of Large Scale Water Distribution Systems.	St. Johns Bayou Pumping Station, Missouri: Hydraulic Model Investigation. W91-11588 8C	Effect of Hydroelectric Stations on Water Quality and Development of Phytoplankton in the
W91-10983 5F		Lower Pools of Reservoirs. W91-11289 6G
Open Channel Velocity Profiles over a Zone of	HYDRAULIC ROUGHNESS Roughness Coefficients of Watercourse Revet-	Operating Experience and Suggestions on Re-
Rapid Infiltration. W91-10984 8B	ted With Half-Circular Concrete Pipes. Results of Field Measurements in Watercourse S 333 at	construction of the Turbines of the Dnepr-I Hy- droelectric Station.
Drag on Vertical Sill of Forced Jump.	Maarkedal.	W91-11290 8C
W91-10985 8B	W91-11431 8B	Distribution and Migration of Heavy Metals in
Surface Dilution of Round Submerged Buoyant Jets.	HYDRAULIC STRUCTURES  Analysis of a Sanitary-Embankment Failure  Over the Rio de Janeiro Soft Clay Deposit.	the Environment of the Altai Mountains in Con- nection with Ecological Substantiation of the
W91-10986 5E	W91-10780 8D	Katun Hydroelectric Station Project. W91-11292 5B
Similarity Solutions of the Shallow Water Equa-	Geotechnical Appraisal of the Foundation Rock	
tions. W91-10987 8B	Mass Behaviour of Narmada Sagar Dam Project, Central India: A Case Study.	HYDROELECTRIC POWER Future Directions for Water Resources.
Operating Experience and Suggestions on Re-	W91-10784 8E	W91-11208 4A
construction of the Turbines of the Dnepr-I Hy- droelectric Station. W91-11290 8C	Deterministic Computer-Aided Optimum Design of Rock Rubble-Mound Breakwater	Development of Small Hydro for Remote Areas of Northern Pakistan. W91-11215 8C
	Cross-Sections. W91-10785 8A	
Hydraulicking in Environmental Protection and	Rocking Armour Units: Number, Location and	Dams and Sustainable Development in Brazilian Amazonia.
Restoration.	Impact Velocity.	W91-11216 8C
W91-11283 5G	W91-10786 8A	Stability of Hydropower Construction Pro-
Method of Calculating the Technological Pa- rameters When Designing Hydraulic-Fill Dams	Seismic Fracture Analysis of Concrete Gravity Dams.	grams. W91-11294 8C
of Silty Soils.	W91-10787 8F	
W91-11284 8A	Economic Analysis of Off-Farm Soil Conserva-	Resale of the Columbia River Treaty Down- stream Power Benefits: One Road from Here to
Assignment of the Class of Hydraulic-Fill Waste Dumps.	tion Structures.	There.
W91-11285 5E	W91-11567 4D	W91-11386 6E
Characteristics of Mining Quarries on Hydrau-	HYDRAULIC VALVES Melvin Price Locks and Dam Auxiliary Lock	HYDROGEN ION CONCENTRATION
lic-Fill Dumps. W91-11286 8A	and Rotary Lock Culvert Valve, Mississippi River, Alton, Illinois: Hydraulic Model Investi-	Species Composition of Fish Communities in Northern Wisconsin Lakes: Relation to pH. W91-10725 5C
HYDRAULIC JUMP	gation.	
Drag on Vertical Sill of Forced Jump. W91-10985 8B	W91-10723 8C	Acid-Base Status of Pennsylvania Streams: Re- sults from the National Stream Survey.
Surface Dilution of Round Submerged Buoyant	HYDRAULICS Hydraulics of Culvert Fishways IV: Spoiler	W91-10726 5B
Jets.	Baffle Culvert Fishways. W91-11279 8I	Design of Economic and Efficient Treatment
W91-10986 5E		Station for Acidic Streams. W91-11077 5G
Experience with Low-Head HydroPlant Fre-	HYDROCARBONS Mechanistic Evaluation of Mitigation of Petrole-	Influence of pH on Phosphate Release from
quency Control.	um Hydrocarbon Contamination by Soil	Sediments.
W91-11214 8C	Medium. W91-10779 5G	W91-11327 2H
Hydroelectric Turbine Setting: A Rational Ap-	Hydrocarbons in Urban Runoff: Their Contribu-	HYDROGEN SULFIDE
proach. W91-11274 8C	tion to the Wastewaters.	Field Survey and Hydraulic Study of 'Aoshio' in Tokyo Bay.
Intake Devices for Dredges with Submersible	W91-10885 5B	W91-10529 5C
Suction Pumps.	Biodegradation of Hydrocarbon Vapors in the	Odour Problems with Sewage Sludge.
W91-11287 8C	Unsaturated Zone. W91-11227 5B	W91-11121 5D
St. Johns Bayou Pumping Station, Missouri: Hydraulic Model Investigation.	Brine-Induced Advection of Dissolved Aromat-	HYDROGRAPH ANALYSIS
W91-11588 8C	ic Hydrocarbons to Arctic Bottom Waters.	Unit Hydrographs for Developing Design Flood Hydrographs.
HYDRAULIC MODELS	W91-11340 5B	W91-10809 2E
Flow Control Technology for Enhancement and Diverse Use of the Marine Environment. W91-10607 2L	HYDRODYNAMICS Geomorphological Dispersion. W91-11232 2E	HYDROGRAPHS Automatic Tracer-Dilution Method Used for
Melvin Price Locks and Dam Auxiliary Lock	HYDROELECTRIC PLANTS	Stage-Discharge Ratings and Streamflow Hy- drographs on Small Iowa Streams.
and Rotary Lock Culvert Valve, Mississippi River, Alton, Illinois: Hydraulic Model Investi-	Converter Application for Mini Hydro Genera- tion.	W91-11111 7B
gation.	W91-11213 8C	HYDROLOGIC BUDGET
W91-10723 8C	Experience with Low-Head HydroPlant Fre-	Land Use, Water Use, Streamflow Characteris- tics, and Water-Quality Characteristics of the
In-Flow Vibrations of Gate Edges. W91-10724 8B	quency Control. W91-11214 8C	Charlotte Harbor Inflow Area, Florida. W91-10771 4C
Investigation of Local Scour in Cohesionless	Development of Small Hydro for Remote Areas	Water Supply Implication of Climate Change in
Sediments Using a Tunnel-Model.	of Northern Pakistan. W91.11215	Western North American Basins.

Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin.	Boundary Element and Particle Tracking Model for Advective Transport in Zoned Aquifers.	Innovative Subsurface Sewage Management: A Program to Protect Idaho's Rathdrum Prairie
W91-11060 5C	W91-10997 2F	Aquifer. W91-11186 5G
Great lakes Hydrological Impacts of 2xCO2 Climate Change.	Discrete-Kernel Method for Simulating Pump- ing Tests in Large-Diameter Wells.	Geologic Framework of the Columbia Plateau
W91-11061 5C	W91-10998 2F	Aquifer System, Washington, Oregon, and Idaho.
Studies on Assessment of Water Balance and Its Quality in Gurpur River Basin, Karnataka State,	Geohydrology and Simulation of Ground-Water Flow in the Mesilla Basin, Dona Ana County,	W91-11571 2F
India. W91-11065 5B	New Mexico, and El Paso County, Texas. W91-11088 2F	ILLINOIS  Hydrological Assesses of the 1988 Decembe in
Effects of the 1988 Drought on Water Resources		Hydrological Aspects of the 1988 Drought in Illinois.
in Wisconsin.	HYDROLOGY Hydrogeochemical Processes Controlling Sub-	W91-10810 2B
W91-11108 2E Selection of the Operating Regime of the Onega-	surface Transport from an Upper Subcatchment of Walker Branch Watershed During Storm	Dynamical Forcing and Mesoscale Organization of Precipitation Bands in a Midwest Winter Cy-
Svir' Water System Under Conditions of In-	Events. 1. Hydrologic Transport Processes.	clonic Storm. W91-11424 2B
creasing Water Consumption. W91-11288 6D	W91-10907 5B	
Method of Compiling Water-Management Bal-	Geomorphological Dispersion. W91-11232 2E	Potential for Aquifer Recharge in Illinois (Ap- propriate Recharge Areas).
ances.		W91-11580 7C
W91-11293 2A	Hydrologic Science: A Distinct Geoscience. W91-11429 2A	IMMUNOASSAY
Interpretation of Hydrologic Effects of Climate Change in the Sacramento-San Joaquin River		Rotavirus Detection: A Problem that Needs
Basin, California.	HYDROPHOBIC COMPOUNDS  Bioavailability of Organic Pollutants in Boreal	Concentration. W91-10656 5A
W91-11552 5C	Waters with Varying Levels of Dissolved Or-	Detection of Rotavirus in South African Waters:
HYDROLOGIC CYCLE	ganic Material. W91-10936 5B	A Comparison of a Cytoimmunolabelling Tech-
Hydrologic Science: A Distinct Geoscience. W91-11429 2A		nique with Commercially Available Immunoas-
	HYPSOMETRIC ANALYSIS  Spatial Distribution of Rainfall in the Greater	says. W91-10660 5A
HYDROLOGIC DATA Hydrochemistry of a Groundwater-Seawater	Athens Area.	
Mixing Zone, Nauru Island, Central Pacific	W91-11416 2B	Salmonella Detection in Sewage Waters Using Fluorescent Antibodies.
Ocean. W91-11297 2K	HYSTERESIS	W91-10687 5D
	Sorption Properties and Moisture Hysteresis of	Immunochemical Detection of Cytochrome
HYDROLOGIC DATA COLLECTIONS  Monthly Mean Discharge at and Between Selected Streamflow-Gaging Stations Along the	Soils. W91-10916 2G	P450IA1 Induction in Cod Larvae and Juveniles Exposed to a Water Soluble Fraction of North
Mississippi, Minnesota, and St. Croix Rivers,	IBM (SAN JOSE) SITE	Sea Crude Oil. W91-10871 5A
1932-87. W91-10760 2E	Superfund Record of Decision: IBM (San Jose), CA.	Development of an Enzyme-Linked Immunosor-
Statistical Summaries of Selected Iowa Stream-	W91-10715 5G	bent Assay for Geosmin.
flow Data Through September 30, 1988.	ICE	W91-10921 5F
W91-10770 2E	Cloud/Cryosphere Interactions. W91-11095 2B	Development of an Enzyme Immunoassay for
Maps of the '400-foot,' '600-foot,' and Adjacent Aquifers and Confining Beds, Baton Rouge		the Determination of Metazachlor. W91-11295 5A
Area, Louisiana.	Periodic Drainage of Ice-Dammed Lakes as a Result of Variations in Glacier Velocity.	
W91-11086 2F	W91-11348 2C	IN SITU TESTS In-Situ Sediment Oxygen Demand in Five
Hydrologic, Meteorological, and Unsaturated-	Snow and Ice Perturbation during Historical	Southwestern U.S. Lakes.
Zone Moisture-Content Data, Franking Lake Playa, Inyo County, California.	Volcanic Eruptions and the Formation of	W91-11333 2H
W91-11089 2F	Lahars and Floods. W91-11394 2C	IN SITU TREATMENT Comparison Between Model Simulations and
Minnesota District, Water Resources Division:	ICE COVER	Field Results for In-Situ Biorestoration of Chlor
Information and Technical Assistance. W91-11167 2F	ICE COVER Subice Layering and Origin of Acidic Waters in	inated Aliphatics: Part 1. Biostimulation o Methanotrophic Bacteria.
	a Small Boreal Lake During the Spring Runoff.	W91-10955 50
Trends in Water-Quality Data in Texas. W91-11593 5B	W91-11229 5B	Soil Clean Up by In-situ Aeration: VI. Effects o
	ICE-DAMMED LAKES	Variable Permeabilities.
HYDROLOGIC MODELS Circulation and Pollutant Dispersion in Masan-	Periodic Drainage of Ice-Dammed Lakes as a Result of Variations in Glacier Velocity.	W91-11317 50
Jinhae Bay of Korea.	W91-11348 2C	Denitrification in Laboratory Sand Columns
W91-10526 5B	ICED LAKES	Carbon Regime, Gas Accumulation and Hy draulic Properties.
Maximum Entropy View of Probability-Distrib- uted Catchment Models.	Periodic Drainage of Ice-Dammed Lakes as a Result of Variations in Glacier Velocity.	W91-11330 50
W91-10965 2A	W91-11348 2C	Migration and Treatment of a Dense Aqueou
Runoff Analysis of the Chang Jiang (The	ICELAND	Contaminant Source and Plume. W91-11380 50
Yangtze River). W91-10966 2E	Periodic Drainage of Ice-Dammed Lakes as a	
	Result of Variations in Glacier Velocity. W91-11348 2C	INCINERATION  Long Climb to Remediation.
Dynamic-Stochastic Models of Rainfall and Snowmelt Runoff Formation.		W91-10483 50
W91-10967 2A	IDAHO Pacific Salmon at the Crossroads: Stocks at Risk	Sewage Sludge Treatment and Use: New Deve
Dynamic Simulation Model of Vertical Infiltra-	from California, Oregon, Idaho, and Washing-	opments, Technological Aspects and Environ
tion of Water in Soil.	ton. W01-10834 8I	mental Effects. W91-11115

## INCINERATION

High-Pressure Dewatering with Polymer Conditioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D	INDUSTRIAL WASTES  Mariculture and Eutrophication in Jinhae Bay, Korea.  W91-10558  5B	Preliminary Data Summary for the Machinery Manufacturing and Rebuilding Industry. W91-11589 5B
W91-1112/	W91-10558 5B	INDUSTRIAL WATER
Technical Requirements and Possibilities of Incineration.	Management of the Marine Environment in Western Australia: An Ecosystem Approach.	Investigations With Electrodialysis Reversal for the Treatment of Surface Water to Make-Up
W91-11129 5D	W91-10583 5G	Water.
Environmental Aspects of Sludge Incineration:	Estimation of Trace Metals Levels in Power and	W91-11368 5F
Overview.	Industrial Waste Water of Jodhpur by Differen-	INFECTION
W91-11130 5E	tial Pulse Anodic Stripping Voltammetry.	Epidemiology of Human Cryptosporidiosis and
Sauras Sludes Instruction and Hillientian of	W91-11084 5A	the Water Route of Infection.
Sewage Sludge Incineration and Utilization of Energy.	The Land Control of the Control	W91-10643 5B
W91-11131 5D	Liquid Effluents: New Solutions to Old Prob- lems.	INFILTRATION
1171.1111	W91-11360 5D	Species and Genera of Enterobacteriaceae in
Sludge Treatment in Amsterdam: Economical,	W91-11300	River Neckar and After River Bank Filtration
Technical and Environmental Experiences.	Treatment of Waste Water From Wet	and Their Resistance Patterns to Antibiotics and
W91-11132 5D	Lime(Stone) Flue Gas Desulfurization Plants	Heavy Metal Salts.
Production of Compost from Sewage Sludge in	With Aid of Crossflow Microfiltration.	W91-10675 5B
Tokyo.	W91-11371 5D	Simple Design for Simultaneous Standy State In
W91-11153 5E	Synthesis and Decomposition of Novel Organo-	Simple Design for Simultaneous Steady-State In- filtration Experiments with Ring Infiltrometers.
Pro-Cala Trible day of Talance A Ash and	phosphorus Complexants.	W91-10813 7B
Beneficial Utilization of Incinerated Ash and Melted Slag.	W91-11372 5D	
W91-11154 5E	D	Spatial and Temporal Influence of Soil Frost on
JE JE	Regulatory Requirements for Pulp and Paper Mill Effluent Control: Scientific Basis and Con-	Infiltration and Erosion of Sagebrush Range-
NDIA	sequences.	lands. W91-10820 2G
Effects of Oil Pollution on Bio-Ecology and	W91-11470 5G	W91-10620 2G
Fisheries on Certain Enclosed Coastal Regions of Arabian Sea.		Comparison of Measured and Estimated Unsatu-
W91-10555 5B	Development of Environmental Control Legis-	rated Hydraulic Conductivities During Snow-
W 91-10333	lation and Effluent Standards for Australasian	melt.
Geotechnical Appraisal of the Foundation Rock	Wood Processing Industries. W91-11472 5G	W91-10904 2G
Mass Behaviour of Narmada Sagar Dam	W91-114/2	Dynamic Simulation Model of Vertical Infiltra-
Project, Central India: A Case Study.	Identification of Dioxin Sources In an Integrated	tion of Water in Soil.
W91-10784 8E	Wood Processing Facility.	W91-10968 2A
Seismic Hazard at Narmada Sagar Dam.	W91-11475 5B	
W91-10949 8E	Biodegradability of Chlorinated Organic Com-	Open Channel Velocity Profiles over a Zone of Rapid Infiltration.
T	pounds In Pulp Bleaching Effluents.	W91-10984 8B
Evidence of Chernobyl Fallout on a Temperate Himalayan Glacier.	W91-11484 5D	W31-10304
W91-10950 5B		Effect of Land Development on Groundwater
W 71-10750	INDUSTRIAL WASTEWATER	Recharge Determined from Non-Steady Chlo-
Comparative Physico-Chemical Analysis of	Preliminary Data Summary for the Pharmaceuti-	ride Profiles.
Drinking, Ground and Industrial Waste Water	cal Manufacturing Point Source Category. W91-10710 5B	W91-10991 4C
of Jodhpur.	W91-10/10	Point-Infiltration Model for Estimating Runoff
W91-11083 5B	Preliminary Data Summary for the Paint For-	from Rainfall on Small Basins in Semiarid Areas
Standard Test Fish for India and the Neighbor-	mulating Point Source Category.	of Wyoming.
ing Countries.	W91-10714 5C	W91-11585 2E
W91-11300 5A	Superfund Record of Decision: Celanese Fibers	INFILTROMETERS
Groundwater Depletion in India: Institutional	Operations, NC.	Simple Design for Simultaneous Steady-State In-
Management Regimes.	W91-10759 5G	filtration Experiments with Ring Infiltrometers.
W91-11382 4B		W91-10813 7B
	Modification of Benthic Community Structure	INDODMATION EVOLUNCE
Heavy Metal Distribution in the Godvari River Basin.	in Response to Acid-Iron Wastes Discharge. W91-10869 5C	INFORMATION EXCHANGE Professionalism in Agriculture: Seeking a Train-
W91-11445 5B	W 91-10809	ing Standard.
38	Impact of Titanium Dioxide Waste on Fertiliza-	W91-11198 5G
Regulatory Influence of Water Current on Algal	tion in the Sea Urchin Echinometra mathaei.	
Colonization in an Unshaded Stream at Shillong	W91-10870 5C	Farmer-Initiated Project to Promote Sustainable
(Meghalaya, India).	Anaerobic Treatability of a Phenolic Coal Con-	Agriculture in Cooperation with the Extension Service.
W91-11451 2E	version Wastewater After Diisopropyl Ether	W91-11203 3F
Activated Sludge Process to Reduce the Pollu-	Extraction.	***************************************
tion Load of a Dye-Industry Waste.	W91-10939 5D	INFORMATION SYSTEMS
W91-11455 5D	Committee Marin Charles A 1 to 10	Establishment of a Groundwater Research Data
Seasonal Variations and Relationships of Differ-	Comparative Physico-Chemical Analysis of Drinking, Ground and Industrial Waste Water	Center for Validation of Subsurface Flow and
ent Physico-chemical Characteristics in Newly	of Jodhpur.	Transport Models. W91-10736 2F
Made Tawa Reservoir.	W91-11083 5B	
W91-11528 2H		Overview of U.S. Geological Survey Water-
Economic Analysis of Soil Consequeties Test	Preliminary Data Summary for Industrial Laun-	Resources Information Programs.
Economic Analysis of Soil Conservation Tech- nologics.	dries. W91-11093 5B	W91-11166 10D
W91-11566 4D	W71-11073	Soil Survey Information System: A User Friend-
	Colour Removal from Textile Effluents by Ad-	ly Soil Information System.
INDICATORS	sorption Techniques.	W91-11174 7C
Comparative Study on Adsorption Mechanisms	W91-11323 5D	AgriCourses The Information Courses C. C.
of RNA-F-Specific Coliphages and Poliovirus in Activated Sludge Process.	Forest Industry Wastewaters.	AgriSource: The Information System for Crop Technology.
W91-10694 5D	W91-11467 5D	W91-11196 10D

NFORMATION TRANSFER	New York City's Delaware River Basin	Area of Southeastern New South Wales: II. In-
Communicating with Farmers: Providing Useful and Reliable Sources of Information.  W91-11164 5G	SupplyA Case Study in Interstate Coopera- tion W91-11046 6E	fluence of Wind-Borne Precipitation. W91-11346 2D
Emerging Issues at the Intersection of Agricul-	INSTREAM FLOW	INTERLABORATORY COMPARISON Preliminary Statistical Assessment of UK Water
tural and Environmental Policy. W91-11165 5G	Aquatic Habitat Measurement and Valuation: Imputing Social Benefits to Instream Flow	Quality Control Trials. W91-10624 5G
Professionalism in Agriculture: Seeking a Train-	Levels. W91-11266 7C	INTERNATIONAL AGREEMENTS
ing Standard.		International Programme for the Protection of a
W91-11198 5G	INSTRUMENTATION Thermal-Pulse Flowmeter for Measuring Slow	Semi-Enclosed Sea: The Mediterranean Action Plan.
Developing a Groundwater Training Program for Pesticide Users.	Water Velocities in Boreholes. W91-10766 8G	W91-10574 5G
W91-11199 5G	Analysis of Ground-Probing Radar Data: Pre-	International and Transboundary Water Re- sources Issues.
Maryland's Train-The-Trainer Program House- hold Hazardous Waste.	dictive Deconvolution. W91-10782 8G	W91-11003 6E
W91-11200 5G	Acoustic Parametric Array for Measuring the	Great Lakes Charter: Potential and Reality.
Farmer-Initiated Project to Promote Sustainable	Thickness and Stratigraphy of Contaminated	W91-11004 6E
Agriculture in Cooperation with the Extension Service.	Sediments. W91-10981 2J	Regional Approach to Drought Planning and Management in the Great Lakes Basin.
W91-11203 3F	Microwave Transmission, a New Tool in Forest	W91-11012 6A
NFRARED IMAGERY	Hydrological Research.	Applying Sustainable Development to the Great
Assessment of VAS-Derived Retrievals and Parameters used in Thunderstorm Forecasting.	W91-10995 2I	Lakes-Experience and Opportunities Under the Boundary Waters Treaty.
W91-11423 2B	Automatic Tracer-Dilution Method Used for Stage-Discharge Ratings and Streamflow Hy-	W91-11019 6E
INJECTION WELLS	drographs on Small Iowa Streams.	Watershed Years at Niagara Falls: Canadian and
Assessment of Hydrogeologic Conditions with	W91-11111 7B	American Policy Responses to New Meanings of
Emphasis on Water Quality and Wastewater In- jection, Southwest Sarasota and West Charlotte	INTAKES	Power, 1905-1914. W91-11038 6E
Counties, Florida.	Open Channel Velocity Profiles over a Zone of Rapid Infiltration.	Will Free Trade Drink Canada Dry.
W91-11087 2F	W91-10984 8B	W91-11041 6D
INLAND SEAS	Intake Devices for Dredges with Submersible	Resale of the Columbia River Treaty Down-
Environmental Management of the Seto Inland Sea.	Suction Pumps.	stream Power Benefits: One Road from Here to
W91-10573 5G	W91-11287 8C	There. W91-11386 6E
INSECT CONTROL	INTEL SITE	
Use of Bacillus thuringiensis var. israelensis to Control the Nuisance Fly Sylvicola fenestralis	Superfund Record of Decision: Intel (Mountain View), CA. W91-11581 5G	INTERNATIONAL BOUNDARY AND WATER COMMIS
(Anisopodidae) in Sewage Filter Beds. W91-10890 5D	INTERAGENCY COOPERATION	Agency Autonomy in Transboundary Resource Management: The United States Section of the
Funding New York State's Integrated Pest Man-	Iterative Evaluation of a Lake Water Quality	International Boundary and Water Commission, United States and Mexico.
agement Program.	Management Program. W91-10808 5G	W91-11388 6E
W91-11180 6C		INTERNATIONAL COMMISSIONS
INSECTICIDES	INTERBASIN TRANSFERS Review of Interbasin Water Transfers with Spe-	Public Health Criteria for the Aquatic Environ-
Simple Spectrophotometric Determination of	cific Attention to Biota.	ment: Recent WHO Guidelines and Their Appli-
Endosulfan in River Water and Soil. W91-11314 5A	W91-11013 6B	cation. W91-10620 5G
St Di Course of Balletins of East	Removal of Biota from Inter-Basin Transfer	Resolving Conflicts on the Danube: The Gabci-
Sheep-Dips as a Source of Pollution of Freshwaters: A Study in Grampian Region.	Water. W91-11017 5F	kovo-Nagymaros Power Dam Project. W91-11018 6B
W91-11356 5B	Managing Transboundary Water Diversions:	
INSTITUTIONAL CONSTRAINTS Applying Sustainable Development to the Great	Experience From a Private Utility. W91-11045 6A	Breaking the Incrementalist Trap: Achieving Unified Management of the Great Lakes Ecosys-
LakesExperience and Opportunities Under the	Regulation of Interbasin Transfers and Con-	tem. W91-11025 6A
Boundary Waters Treaty. W91-11019 6E	sumptive Uses from the Great Lakes.	Danube River Basin: Negotiating Settlements to
Limits of Government Responsibility.	W91-11384 6E	Transboundary Environmental Issues.
W91-11034 6E	INTERCEPTION Rainfall Interception and Boundary Layer Con-	W91-11387 3G
What Stakeholders Want and Why. W91-11035 6A	ductance in Relation to Tree Spacing. W91-10905 2I	Agency Autonomy in Transboundary Resource Management: The United States Section of the International Boundary and Water Commission,
Institutional Morass: Constraints and Opportuni-	Microwave Transmission, a New Tool in Forest	United States and Mexico.
ties for Issue Management.	Hydrological Research. W91-10995 2I	W91-11388 6E
		INTERNATIONAL JOINT COMMISSION
So What. Findings and Recommendations from the Lake Levels Study.	INTERCEPTION LOSS Rainfall Interception by Trees of Pinus radiata	Breaking the Incrementalist Trap: Achieving Unified Management of the Great Lakes Ecosys-
W91-11037 6A	and Eucalyptus viminalis in a 1300 mm Rainfall	tem. W91-11025 6A
INSTITUTIONS	Area of Southeastern New South Wales: I. Gross Losses and Their Variability.	
Breaking the Incrementalist Trap: Achieving Unified Management of the Great Lakes Ecosys-	W91-11345 2D	Fluctuating Water Levels in the Great Lakes-St. Lawrence River Basin: An Evaluation Frame-
tem.	Rainfall Interception by Trees of Pinus radiata and Eucalyptus viminalis in a 1300 mm Rainfall	work for the Analysis of Potential Actions. W91-11026 6B
W91-11025 6A	and Eucatypius vinimans in a 1500 min Raiman	

# INTERNATIONAL JOINT COMMISSION

Great Lakes Water Levels Management: Relax-	Comparative Water Management: A Tale of	ION TRANSPORT
ing the 'Policy Trap'. W91-11027 6A	Two Compacts. W91-11042 6A	Major Ions in Marine Rainwater With Attention to Sources of Alkaline and Acidic Species.
Successes and Challenges in Developing and	N V Circle Dalaman Disas Dalaman	W91-11250 5B
Implementing Remedial Action Plans to Restore Degraded Areas of the Great Lakes.	New York City's Delaware River Basin SupplyA Case Study in Interstate Coopera- tion	ION TRAP MASS SPECTROMETRY Direct Sampling Ion Trap Mass Spectrometry
W91-11030 6A	W91-11046 6E	for the Rapid Determination of Volatile Organ-
Fluctuating Great Lakes Water Levels: Progress	INTERSTITIAL WATER	ics in Environmental Matrices. W91-11555 5A
and Opportunities. W91-11032 6A	Chemical Composition of the Interstitial Water	IONS
	in Bottom Sediments of Tyrrhenian Sea (West- ern Mediterranean): Diagenetic Processes.	Ion Concentrations in Interstitial Water as Indi-
Institutional Morass: Constraints and Opportuni- ties for Issue Management.	W91-10880 2J	cators for Phosphorus Release Processes and Reactions.
W91-11036 6A	Ion Concentrations in Interstitial Water as Indi-	W91-10888 2K
NTERNATIONAL LAW	cators for Phosphorus Release Processes and	Main Ton in Main Brianna With Association
Danube River Basin: Negotiating Settlements to Transboundary Environmental Issues.	Reactions. W91-10888 2K	Major Ions in Marine Rainwater With Attention to Sources of Alkaline and Acidic Species.
W91-11387 5G		W91-11250 5B
Agency Autonomy in Transboundary Resource	INTERTIDAL AREAS Annual Bacterial Production in Relation to	IOWA
Management: The United States Section of the	Benthic Microalgal Production and Sediment	Statistical Summaries of Selected Iowa Stream-
International Boundary and Water Commission, United States and Mexico.	Oxygen Uptake in an intertidal Sandflat and an	flow Data Through September 30, 1988. W91-10770 2E
W91-11388 6E	Intertidal Mudflat. W91-10865 2L	
NTERNATIONAL WATERS		Evidence for Dilution of Deep, Confined Ground Water by Vertical Recharge of Isotopi-
International and Transboundary Water Re-	Behavior of Heavy Metals in a Mud Flat of the Scheldt Estuary, Belgium.	cally Heavy Pleistocene Water.
sources Issues.	W91-10872 5B	W91-10792 2F
W91-11003 6E	Use of the Intertidal Zone by Fish in Nova	Funding Groundwater Protection Programs:
Exporting Himalayan Floods.	Scotia.	Iowa's Groundwater Protection Fund.
W91-11014 2E	W91-11557 2L	W91-11179 5G
Flood Forecasts on Transboundary Rivers in	INTRODUCED SPECIES	Farmer-Initiated Project to Promote Sustainable
Hungary with Parallels in Canada. W91-11015 4A	Introduced SpeciesResource or Threat in	Agriculture in Cooperation with the Extension Service.
Political Economic Model of International Pol-	Brackish-Water Seas: Examples from the Baltic and Black Sea.	W91-11203 3F
lution.	W91-10552 2L	IRAN
W91-11016 5B		Regional Approach to Salinity Management in
Resolving Conflicts on the Danube: The Gabci- kovo-Nagymaros Power Dam Project.	Testing of Cellular Concrete Revetment Blocks Resistant to Growths of Reynoutria japonica Houtt (Japanese Knotweed).	River Basins. A Case Study in Southern Iran. W91-11432 5G
W91-11018 6B	W91-10942 8F	IRAQ
Effects of Changes in Land Use on Annual	INVERTEBRATES	Bacteriological Suitability of Water from Basrah
Streamflows in the Lake Huron Basin of Canada and the United States.	Atrazine Hazards to Fish, Wildlife, and Inverte-	Wells for Drinking. W91-10629 5A
W91-11021 4C	brates: A Synoptic Review.	IRELAND
Watershed Years at Niagara Falls: Canadian and	W91-10709 5C	Precipitation in Britain: An Analysis of Area-
American Policy Responses to New Meanings of	Macroinvertebrate Responses along a Complex	Average Data Updated to 1989.
Power, 1905-1914.	Regulated Stream Environmental Gradient. W91-10848 4A	W91-10973 2B
W91-11038 6E		Sequential Sampling of Particles, Major Ions and
Milk River: Historical Transitions in an Interna-	INVERTERS	Total Trace Metals in Wet Deposition. W91-11249 5B
tional Waterway. W91-11039 6E	Converter Application for Mini Hydro Genera- tion.	
	W91-11213 8C	IRON Determination of Subnanomolar Levels of
Water Diversion from the Great Lakes as a Dynamic Game.	IODIDES	Iron(II) and Total Dissolved Iron in Seawater
W91-11051 6B	Iodine Chemistry in the Water Column of the	by Flow Injection Analysis with Chemilumines-
INTERSTATE COMMISSIONS	Chesapeake Bay: Evidence for Organic Iodine Forms.	cence Detection. W91-10773 2K
Challenge of Implementing Ecosystem Manage-	W91-10496 2L	
ment Plans in the Great Lakes Basin. W91-11011 6B		Modification of Benthic Community Structure in Response to Acid-Iron Wastes Discharge.
	IODINE Iodine Chemistry in the Water Column of the	W91-10869 5C
INTERSTATE COMPACTS What Makes Regional Organizations Succeed or	Chesapeake Bay: Evidence for Organic Iodine	Impact of Titanium Dioxide Waste on Fertiliza-
Fail.	Forms.	tion in the Sea Urchin Echinometra mathaei.
W91-11005 6A	W91-10496 2L	W91-10870 5C
Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes and Failures.	Comparative Inactivation of Hepatitis A Virus and Other Enteroviruses in Water by Iodine. W91-10679 5F	Multicomponent Kinetic Analysis of Iron Speci- ation in Humic Lake Tjeukemeer: Comparison of Fulvic Acid from the Drainage Basin and
W91-11008 6E	ION EXCHANGE	Lake Water Samples.
Interstate Cooperation in Dealing with Growth	Extraction of Heavy Metals from Sludges and	W91-11339 2H
Related Water Quality Impacts on the Chesa- peake Bay.	Muds by Magnetic Ion-Exchange. W91-11145 5D	Pre-hydrolyzed Aluminum Hydroxide and Iron Hydroxide in Activated Sludge Treatment.
W91-11009 6E	Determination of Trace Levels of Sulphate in	W91-11539 5D
Regional Approach to Drought Planning and	Water Using Flow-Injection and In-Line Pre-	Magnetite Formation During Microbial Dissimi-
Management in the Great Lakes Basin. W91-11012 6A	concentration. W91-11246 2K	latory Iron Reduction. W91-11544
W91-11012 6A	W71-11240 2K	W91-11544 21

IRON HORSE PARK SITE	Production Functions Relating Crop Yield,	JAMAICA
Superfund Record of Decision: Iron Horse Park,	Water Quality and Quantity, Soil Salintiy and	Dynamics of Pesticides in Tropical Conditions.
MA.	Drainage Volume.	1. Kinetic Studies of Volatilization, Hydrolysis,
W91-10719 5G	W91-11434 3C	and Photolysis of Dieldrin and Alpha and Beta
IRRADIATION	ISE BAY	Endosulfan.
Treatment of Pulp-Bleaching Effluents by Acti-	Distribution of Chlorobenzenes in the Bottom	W91-11375 5B
vated Sludge, Precipitation, Ozonation and Irra-	Sediments of Ise Bay.	JAPAN
diation.	W91-11324 5B	Analysis of Precipitation Chemistry Measure-
W91-11491 5D	Debasies of Chloseberross is Inc Box February	ments in Shimane, Japan.
IRRIGATION	Behavior of Chlorobenzenes in Ise Bay, Estimat- ed from Their Concentrations in Various Envi-	W91-10472 2B
Adoption of Water-Savings Practices by Irriga-	ronmental Media.	
tors in the High Plains.	W91-11325 5B	Meteorology and Oceanography in the Seto
W91-10821 3F		Inland Sea.
	ISLANDS	W91-10520 2L
Water Use of a Winter Wheat Cultivar (Triti-	Hydrochemistry of a Groundwater-Seawater	Runoff Characteristics of COD, BOD, C, N, and
cum Aestivum). W91-11436 3F	Mixing Zone, Nauru Island, Central Pacific	P Loadings from Rivers to Enclosed Coastal
W91-11436 3F	Ocean. W91-11297 2K	Seas.
IRRIGATION EFFECTS	W91-11297	W91-10521 5B
Assessment of the Salinity Tolerance of Eight	ISOLATION	
Sonoran Desert Riparian Trees and Shrubs.	Isolation and Identification of Cryptosporidium	Water Exchange and Transport of Matter in the Seto Inland Sea.
W91-10752 3C	from Water.	W91-10527 2L
Causes of Degradation of Chemical and Physical	W91-10644 5A	W91-10327 2L
Properties of Chernozems Irrigated with Non-	ISOPODS	Numerical Simulation of Water Quality in
mineralized Water.	Gammarus: Asellus Ratio as an Index of Organic	Tokyo Bay.
W91-10913 2G	Pollution.	W91-10528 5B
	W91-11331 5A	
Effect of Long-Term Application of Fertilizers		Field Survey and Hydraulic Study of 'Aoshio' in
on the Agrophysical Properties of an Irrigated	ISOTHERMS	Tokyo Bay. W91-10529 5C
Light-Chestnut Soil. W91-10914 2G	Lead Sorption in Calcareous Soils.	W91-10529 5C
11/2/10/14	W91-11453 5B	Eutrophication in Hiroshima Bay.
Physical Properties of Irrigated Chernozems of	ISOTOPE STUDIES	W91-10536 5B
the Southern Ukraine.	First-Order Organic Carbon Budget in the St	
W91-10915 2G	Lawrence Lower Estuary from 13C Data.	Heavy Metal Pollution in Sediment from the
Salinity and Evaporation in the River Murray	W91-10498 2L	Seto Inland Sea, Japan.
Basin, Australia.	Projection of Later Study for Policetics	W91-10537 5B
W91-10989 2E	Environmental Isotope Study for Estimating Leakage and Runoff of Ground Waters in the	Change of Oceanic Condition by the Man-Made
	Xi'an Area.	Structure for Upwelling.
Management of Irrigation-Induced Contami-	W91-10994 2F	W91-10542 8I
nants. W91-11063 5G		
W91-11063 5G	ISOTOPIC TRACERS	Summary of Ports and Marine Environment Im-
Groundwater Depletion in India: Institutional	Use of 137Cs as a Tracer in an Erosion Study in	provement Work and Example of Latest Meas-
Management Regimes.	South Limburg (The Netherlands) and the Influ-	ures in Seto Inland Sea.
W91-11382 4B	ence of Chernobyl Fallout. W91-11351 7B	W91-10545 5G
Aral Sea Basin: A Critical Environmental Zone.	W91-11331	Life Cycle Strategies of the Red Tide Causing
W91-11441 6G	ISRAEL	Flagellates Chattonella (Raphidophyceae) in the
***************************************	Eastern Mediterranean: A Marine Desert.	Seto Inland Sea.
IRRIGATION PRACTICES	W91-10553 2H	W91-10546 5B
Water Control Systems and the Traditional Fes-	Man-Made Garbage Pollution on the Mediterra-	B of Atic Asimala in Dahai Bau
tival at Miyawaki, on the Seto Inland Sea. W91-10591 3F	nean Coastline.	Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.
W91-10591 3F	W91-10569 5B	W91-10550 5G
Adoption of Water-Savings Practices by Irriga-		W 91-10330
tors in the High Plains.	Distribution of Fecal Pollution Indicator Bacte-	Benthic Faunal Succession in a Cove Organical-
W91-10821 3F	ria in Lake Kinneret.	ly Polluted by Fish Farming.
IRRIGATION PROGRAMS	W91-11322 5B	W91-10554 5C
Implications of Full-Cost Recovery Water Rates	ITALY	Ecological Modelling at Osaka Bay Related to
on Irrigated Farms in Saskatchewan.	Effects of Pollution on Heterozygosity in the	Long-Term Eutrophication.
W91-11054 6C	Barnacle Balanus amphitrite (Cirripedia: Thora-	W91-10556 5C
	cica).	1171-10550
IRRIGATION PROJECTS	W91-10518 5C	Kansai International Airport Project and Envi-
'Parque de Donana', and Its Contribution to Environmental Activities for Environmental	Man-Made Garbage Pollution on the Mediterra-	ronmental Impact Assessment.
Protection.	nean Coastline.	W91-10563 4C
W91-10586 5G	W91-10569 5B	Toward Favingenestal Blancing for Fact Asian
		Toward Environmental Planning for East Asian Estuaries: Japanese and Chinese Enclosed Bays
IRRIGATION REQUIREMENTS	Control of Enteric Micro-organisms by Aerobic-	W91-10565 2L
Water Use of a Winter Wheat Cultivar (Triti-	Thermophilic Co-Composting of Wastewater Sludge and Agro-Industry Sludge.	
cum Aestivum). W91-11436 3F	W91-10693 5E	Countermeasures Against Water Pollution in
W91-11436 3F		Enclosed Coastal Seas in Japan.
IRRIGATION WATER	Seasonal Variations of Aliphatic Hydrocarbons	W91-10572 5G
Implications of Full-Cost Recovery Water Rates	in Sardina pilchardus (Walb.) (Teleostei: Clupei-	Environmental Management of the Seto Inland
on Irrigated Farms in Saskatchewan.	dae) Tissues.	Sea.
W91-11054 6C	W91-10839 5B	W91-10573 5G
Effect of Low Salinity Water on Salt Displace-	Modifications of Some Physical Properties in	
ment in Two Soils.	Two Compost-Amended Italian Soils.	Sea and Fresh Water Conservation.
W91-11433 2G	W91-11148 5E	W91-10578 5G

Controlling Effect of the Planned Management	JAPANESE KNOTWEED	KESTERSON RESERVOIR
of the Environment in the Kagoshima Bay on the Pollutant Load.	Testing of Cellular Concrete Revetment Blocks Resistant to Growths of Reynoutria japonica	Management of Irrigation-Induced Contami-
W91-10579 5G	Houtt (Japanese Knotweed).	nants. W91-11063 5G
	W91-10942 8F	W31-11003
Personal Computer System Supporting Water	JETS	KEUKA LAKE
Quality Management in Eutrophicated Bay. W91-10582 5G	Surface Dilution of Round Submerged Buoyant	Iterative Evaluation of a Lake Water Quality
	Jets.	Management Program. W91-10808 5G
Citizen's Movements to Protect the Environ-	W91-10986 5E	
ment of Rivers Flowing into the Seto Inland Sea: An Example of a Citizen's Movement	JIHLAVA RIVER	KIN-BUC LANDFILL
Along the Toga River.	Microzoobenthos of the River Jihlava After the	Superfund Record of Decision: Kin-Buc Land-
W91-10587 5G	Construction of the Dalesice Waterworks.	fill, NJ. W91-10755 5G
Water Control Systems and the Traditional Fes-	W91-11521 6G	
tival at Miyawaki, on the Seto Inland Sea.	JINHAE BAY	KINETICS
W91-10591 3F	Mariculture and Eutrophication in Jinhae Bay,	Kinetics of Chemical Weathering in B Horizon Spodosol Fraction.
Formation of Oxygen-Deficient Water Mass in	Korea. W91-10558 5B	W91-11233 5C
Omura Bay.	W 91-10336	
W91-10592 5B	JODHPUR	KINGSTON BASIN
Entrophication Machanisms of Casatal Sant in	Comparative Physico-Chemical Analysis of Drinking, Ground and Industrial Waste Water	Summer Circulation in the Kingston Basin, Lake Ontario.
Eutrophication Mechanisms of Coastal Seas in Yamaguchi Prefecture.	of Jodhpur.	W91-10978 2H
W91-10593 5B	W91-11083 5B	W 91-10976
	Polanda d'Esta Maria I al la Para de la	KLEINER BARSCH-SEE
Regional-Wide Waste Disposal Project on Sea- coast of Enclosed Coastal Sea.	Estimation of Trace Metals Levels in Power and Industrial Waste Water of Jodhpur by Differen-	Geographical and Pollenanalytical Research of
W91-10594 5E	tial Pulse Anodic Stripping Voltammetry.	Lake Kleiner Barsch-See (Bez. Potsdam, GDR) (Geographische und Pollenanalytische Untersu-
	W91-11084 5A	chungen des Kleinen Barsch-Sees) (Bez. Pots-
Comparison of Nutritional Environment of	JORDAN RIVER	dam, DDR).
Closed Coastal Seas in Western Kyushu. W91-10595 2L	Distribution of Fecal Pollution Indicator Bacte-	W91-11514 2H
W 31-10333	ria in Lake Kinneret.	History of Cladocera in the Kleiner Barsch-See,
Water Quality Purification System for the En-	W91-11322 5B	an Acidic, Calcium-Poor, Marshy Pond in the
closed Sea Area. W91-10596 5G	KAGOSHIMA BAY	Middle European Flatland (Die Geschichte der
W91-10396	Controlling Effect of the Planned Management	Cladocerenfauna des Kleinen Barsch-Sees, eines
Marine Pollution Bioassay by Using Sea Urchin	of the Environment in the Kagoshima Bay on	Sauren, Kalkarmen Moorweihers im Mitteleuro- paischen Flachland).
Eggs in the Tanabe Bay, Wakayama Prefecture, Japan, 1970-1987.	the Pollutant Load. W91-10579 5G	W91-11515 2H
W91-10602 5A	W91-103/9	
	KALAMAZOO COUNTY	Analysis of Subfossil Shelled Protozoa in the
Construction of Artificial Seaweed Bed Accom-	Geohydrology and Water Quality of Kalamazoo County, Michigan, 1986-88.	Sediments of a Small Acid Forest Lake (Kleiner Barsch-See, Northern GDR) (Analyse Subfos-
panied with the Reclamation for Unit No. 3 of Ikata Power Station.	W91-11091 2F	siler Protozoenschalen der Sedimente eines
W91-10603 2L	-	Kleinen Sauren Waldsees) (Kleiner Barsch-See,
S101	KANSAI INTERNATIONAL AIRPORT	Nordliche DDR). W91-11516 2H
Seasonal Changes of Organic Carbon and Nitro- gen Production by Phytoplankton in the Estuary	Kansai International Airport Project and Envi- ronmental Impact Assessment.	W91-11316 2H
of River Tamagawa.	W91-10563 4C	Diatom Analysis, Late-Glacial and Post-Glacial
W91-10604 5B	KANSAS	Development of Lake Kleiner Barsch-See
Succession of Benthic Assemblages in Wild Bird	Northwest Kansas Groundwater Management	(GDR)-A Preliminary Note. W91-11517 2H
Park, a Sanctuary Established on Reclaimed	District No. 4. An Abandoned Well Program.	W31-11317 211
Land in Osaka Port.	W91-11188 5G	Chemical Composition of Late- and Post-Glacial
W91-10606 2L	KARST	Sediments (Fe, Mn, P, C, N, N, H and BSi) in
Flow Control Technology for Enhancement and	Hydrology of the Arbuckle Mountains Area,	Lake Kleiner Barsch-See, a Bog Lake in the North of GDR (Die Chemische Zusammenset-
Diverse Use of the Marine Environment.	South-Central Oklahoma.	zung der Spat- und Postglazialsedimente des
W91-10607 2L	W91-11590 2F	Kleinen Barsch-Sees (Fe, Mn, P, C, N, H und
East Asian Seas: Hypothetical Oil Spill Trajec-	KARST HYDROLOGY	BSi), eines Dystrophen Moorweihers im Norden der DDR).
tories.	Contribution to the Study of the Bossesian	
W201 10400	Contribution to the Study of the Recession	W91-11518 2H
W91-10608 5B	Curves of Karstic Springs: Examples from	
Computer Visualization System for Sediment	Curves of Karstic Springs: Examples from Greece (Contribution a l'Etude des Courses de	KOREA
Computer Visualization System for Sediment Pollution in Japan.	Curves of Karstic Springs: Examples from Greece (Contribution a l'Etude des Courses de Recession des Sources Karstiques: Exemples du Pays Hellenique).	KOREA Circulation and Pollutant Dispersion in Masan-
Computer Visualization System for Sediment	Curves of Karstic Springs: Examples from Greece (Contribution a l'Etude des Courses de Recession des Sources Karstiques: Exemples du	KOREA
Computer Visualization System for Sediment Pollution in Japan. W91-10609 7C	Curves of Karstic Springs: Examples from Greece (Contribution a l'Etude des Courses de Recession des Sources Karstiques: Exemples du Pays Hellenique).  W91-10990  2F	KOREA Circulation and Pollutant Dispersion in Masan- Jinhae Bay of Korea. W91-10526 5B
Computer Visualization System for Sediment Pollution in Japan. W91-10609 7C Improvement of the Zeta-Plus Filter Method for Concentration of Viruses from Water.	Curves of Karstic Springs: Examples from Greece (Contribution a l'Etude des Courses de Recession des Sources Karstiques: Exemples du Pays Hellenique).  W91-10990  2F  Hydrochemistry of a Groundwater-Seawater Mixing Zone, Nauru Island, Central Pacific	KOREA Circulation and Pollutant Dispersion in Masan- Jinhae Bay of Korea. W91-10526 5B Mariculture and Eutrophication in Jinhae Bay,
Computer Visualization System for Sediment Pollution in Japan. W91-10609 7C Improvement of the Zeta-Plus Filter Method for	Curves of Karstic Springs: Examples from Greece (Contribution a l'Etude des Courses de Recession des Sources Karstiques: Exemples du Pays Hellenique). W91-10990 2F Hydrochemistry of a Groundwater-Seawater Mixing Zone, Nauru Island, Central Pacific Ocean.	KOREA Circulation and Pollutant Dispersion in Masan-Jinhae Bay of Korea. W91-10526 5B Mariculture and Eutrophication in Jinhae Bay, Korea.
Computer Visualization System for Sediment Pollution in Japan. W91-10609 7C Improvement of the Zeta-Plus Filter Method for Concentration of Viruses from Water. W91-10655 5A	Curves of Karstic Springs: Examples from Greece (Contribution a l'Etude des Courses de Recession des Sources Karstiques: Exemples du Pays Hellenique).  W91-10990  2F  Hydrochemistry of a Groundwater-Seawater Mixing Zone, Nauru Island, Central Pacific	KOREA Circulation and Pollutant Dispersion in Masan- Jinhae Bay of Korea. W91-10526 5B Mariculture and Eutrophication in Jinhae Bay, Korea. W91-10558 5B
Computer Visualization System for Sediment Pollution in Japan. W91-10609 7C Improvement of the Zeta-Plus Fülter Method for Concentration of Viruses from Water. W91-10655 5A Existing Conditions for Agricultural Utilization of Sewage Sludge Compost in Japan.	Curves of Karstic Springs: Examples from Greece (Contribution a l'Etude des Courses de Recession des Sources Karstiques: Exemples du Pays Hellenique).  W91-10990  2F  Hydrochemistry of a Groundwater-Seawater Mixing Zone, Nauru Island, Central Pacific Ocean.  W91-11297  2K  Use of Electronic Data-Logging Equipment to	KOREA Circulation and Pollutant Dispersion in Masan-Jinhae Bay of Korea. W91-10526 5B Mariculture and Eutrophication in Jinhae Bay, Korea. W91-10558 5B KRAFT MILLS
Computer Visualization System for Sediment Pollution in Japan. W91-10609 7C Improvement of the Zeta-Plus Filter Method for Concentration of Viruses from Water. W91-10655 5A Existing Conditions for Agricultural Utilization	Curves of Karstic Springs: Examples from Greece (Contribution a l'Etude des Courses de Recession des Sources Karstiques: Exemples du Pays Hellenique).  W91-10990  2F  Hydrochemistry of a Groundwater-Seawater Mixing Zone, Nauru Island, Central Pacific Ocean.  W91-11297  2K  Use of Electronic Data-Logging Equipment to Monitor Hydrologic Parameters in a Humid	KOREA Circulation and Pollutant Dispersion in Masan-Jinhae Bay of Korea. W91-10526 5B Mariculture and Eutrophication in Jinhae Bay, Korea. W91-10558 5B KRAFT MILLS Membrane Filtration Combined with Biological
Computer Visualization System for Sediment Pollution in Japan. W91-10609 7C Improvement of the Zeta-Plus Filter Method for Concentration of Viruses from Water. W91-10655 5A Existing Conditions for Agricultural Utilization of Sewage Sludge Compost in Japan. W91-11152 5E	Curves of Karstic Springs: Examples from Greece (Contribution a l'Etude des Courses de Recession des Sources Karstiques: Exemples du Pays Hellenique). W91-10990 2F Hydrochemistry of a Groundwater-Seawater Mixing Zone, Nauru Island, Central Pacific Ocean. W91-11297 2K Use of Electronic Data-Logging Equipment to Monitor Hydrologic Parameters in a Humid Cave Environment in Wind Cave National Park,	KOREA Circulation and Pollutant Dispersion in Masan-Jinhae Bay of Korea. W91-10526 5B Mariculture and Eutrophication in Jinhae Bay, Korea. W91-10558 5B KRAFT MILLS
Computer Visualization System for Sediment Pollution in Japan. W91-10609 7C Improvement of the Zeta-Plus Filter Method for Concentration of Viruses from Water. W91-10655 5A Existing Conditions for Agricultural Utilization of Sewage Sludge Compost in Japan. W91-11152 5E Production of Compost from Sewage Sludge in Tokyo.	Curves of Karstic Springs: Examples from Greece (Contribution a l'Etude des Courses de Recession des Sources Karstiques: Exemples du Pays Hellenique).  W91-10990  2F  Hydrochemistry of a Groundwater-Seawater Mixing Zone, Nauru Island, Central Pacific Ocean.  W91-11297  2K  Use of Electronic Data-Logging Equipment to Monitor Hydrologic Parameters in a Humid	KOREA Circulation and Pollutant Dispersion in Masan-Jinhae Bay of Korea. W91-10526 5B Mariculture and Eutrophication in Jinhae Bay, Korea. W91-10558 5B KRAFT MILLS Membrane Filtration Combined with Biological Treatment for Purification of Bleach Plant Ef-
Computer Visualization System for Sediment Pollution in Japan. W91-10609 7C Improvement of the Zeta-Plus Filter Method for Concentration of Viruses from Water. W91-10655 5A Existing Conditions for Agricultural Utilization of Sewage Sludge Compost in Japan. W91-11152 5E Production of Compost from Sewage Sludge in	Curves of Karstic Springs: Examples from Greece (Contribution a l'Etude des Courses de Recession des Sources Karstiques: Exemples du Pays Hellenique).  W91-10990  2F  Hydrochemistry of a Groundwater-Seawater Mixing Zone, Nauru Island, Central Pacific Ocean.  W91-11297  2K  Use of Electronic Data-Logging Equipment to Monitor Hydrologic Parameters in a Humid Cave Environment in Wind Cave National Park, South Dakota.  W91-11389  7B	KOREA Circulation and Pollutant Dispersion in Masan-Jinhae Bay of Korea. W91-10526 5B Mariculture and Eutrophication in Jinhae Bay, Korea. W91-10558 5B KRAFT MILLS Membrane Filtration Combined with Biological Treatment for Purification of Bleach Plant Effuents. W91-11490 5D
Computer Visualization System for Sediment Pollution in Japan. W91-10609 7C Improvement of the Zeta-Plus Filter Method for Concentration of Viruses from Water. W91-10655 5A Existing Conditions for Agricultural Utilization of Sewage Sludge Compost in Japan. W91-11152 5E Production of Compost from Sewage Sludge in Tokyo.	Curves of Karstic Springs: Examples from Greece (Contribution a l'Etude des Courses de Recession des Sources Karstiques: Exemples du Pays Hellenique).  W91-10990  2F  Hydrochemistry of a Groundwater-Seawater Mixing Zone, Nauru Island, Central Pacific Ocean.  W91-11297  2K  Use of Electronic Data-Logging Equipment to Monitor Hydrologic Parameters in a Humid Cave Environment in Wind Cave National Park, South Dakota.  W91-11389  7B  KENTUCKY	KOREA Circulation and Pollutant Dispersion in Masan-Jinhae Bay of Korea. W91-10526 5B Mariculture and Eutrophication in Jinhae Bay, Korea. W91-10558 5B KRAFT MILLS Membrane Filtration Combined with Biological Treatment for Purification of Bleach Plant Effuents. W91-11490 5D Investigation of Anaerobic Removal and Degra-
Computer Visualization System for Sediment Pollution in Japan. W91-10609 7C Improvement of the Zeta-Plus Filter Method for Concentration of Viruses from Water. W91-10655 5A Existing Conditions for Agricultural Utilization of Sewage Sludge Compost in Japan. W91-11152 5E Production of Compost from Sewage Sludge in Tokyo. W91-11153 5E	Curves of Karstic Springs: Examples from Greece (Contribution a l'Etude des Courses de Recession des Sources Karstiques: Exemples du Pays Hellenique).  W91-10990  2F  Hydrochemistry of a Groundwater-Seawater Mixing Zone, Nauru Island, Central Pacific Ocean.  W91-11297  2K  Use of Electronic Data-Logging Equipment to Monitor Hydrologic Parameters in a Humid Cave Environment in Wind Cave National Park, South Dakota.  W91-11389  7B	KOREA Circulation and Pollutant Dispersion in Masan-Jinhae Bay of Korea. W91-10526 5B Mariculture and Eutrophication in Jinhae Bay, Korea. W91-10558 5B KRAFT MILLS Membrane Filtration Combined with Biological Treatment for Purification of Bleach Plant Effuents. W91-11490 5D

Activated Sludge Treatment of Kraft Mill Ef-	LAKE ECOLOGY	LAKE ONEGA
fluents from Conventional and Oxygen Bleach- ing.	Primary Productivity and Plankton Communi- ties in a Two-Reservoir Series.	Selection of the Operating Regime of the Onega- Svir' Water System Under Conditions of In-
W91-11511 5D	W91-10815 2H	creasing Water Consumption. W91-11288 6D
KRIGING	Longitudinal Development of Macroinverte-	W 71-11200
Statistical Analysis of Errors in Estimating Wet	brate Communities Below Oligotrophic Lake	LAKE ONTARIO
Deposition Using Five Surface Estimation Algo-	Outlets.	Summer Circulation in the Kingston Basin, Lake
rithms.	W91-10856 2H	Ontario.
W91-10474 7B	Zooplankton Effects on Phytoplankton in Lakes	W91-10978 2H
T A BOD AMONY HOLITAN	of Contrasting Trophic Status.	Optics of Little Sodus Bay.
LABORATORY EQUIPMENT	W91-10859 2H	W91-10980 2H
Application of HPLC Column-Switching in Pes- ticide Residue Analysis.		11 71-10700
W91-11308 5A	Impact of Physico-chemical Complexes on	Acoustic Parametric Array for Measuring the
W 91-11306	Plankton Density in Dhir Beel of Assam.	Thickness and Stratigraphy of Contaminated
LABORATORY METHODS	W91-11527 2H	Sediments.
Continuous Flow Thin-Layer Headspace	LAKE-EFFECT PRECIPITATION	W91-10981 2J
(TLHS) Analysis. I. Conductometric Determi-	Estimating the Effects on the Regional Precipi-	Regulation of Lake Ontario Levels.
nation of Volatile Organic Halogens (VOX) in	tation Climate in a Semiarid Region Caused by	W91-11028 6A
Tap Water.	an Artificial Lake Using a Mesoscale Model.	
W91-11256 5A	W91-10502 2B	LAKE RESTORATION
Use of a Single-Bowl Continuous-Flow Centri-	TAPE PRIE	Lake Lansing Dredging Evaluation Study, 1978-
fuge for Dewatering Suspended Sediments:	LAKE ERIE  Modeling Lake Erie as a Stochastic Linear Res-	1984.
Effect on Sediment Physical and Chemical	ervoir.	W91-10748 5G
Characteristics.	W91-11029 7C	Delay in Lake Recovery Caused by Internal
W91-11350 7B	117111027	Loading.
	LAKE FISHERIES	W91-10886 2H
Measuring Low Radon Levels in Drinking	Species Composition of Fish Communities in	
Water Supplies.	Northern Wisconsin Lakes: Relation to pH.	Successes and Challenges in Developing and
W91-11463 5A	W91-10725 5C	Implementing Remedial Action Plans to Restore
Chemical and Biological Factors Affecting Acid	LAKE HURON	Degraded Areas of the Great Lakes. W91-11030 6A
Tolerance of Smallmouth Bass.	Effects of Changes in Land Use on Annual	W91-11030 6A
W91-11530 5C	Streamflows in the Lake Huron Basin of Canada	Socio-Economic Considerations in Remedial
	and the United States.	Action Planning for the Great LakesA Case
Direct Sampling Ion Trap Mass Spectrometry	W91-11021 4C	Study for Sustainable Development.
for the Rapid Determination of Volatile Organ-		W91-11031 6A
ics in Environmental Matrices.	LAKE ICE	Dubbleless Assetion
W91-11555 5A	Subice Layering and Origin of Acidic Waters in a Small Boreal Lake During the Spring Runoff.	Bubbleless Aeration. W91-11222 5G
LAGOONS	W91-11229 5B	W91-11222
Status of Eutrophication in the Great Barrier	W 71-11227 JB	LAKE SEDIMENTS
Reef Lagoon.	LAKE KINNERET	Role of Seasonal Turnover in Lake Alkalinity
W91-10535 5B	Distribution of Fecal Pollution Indicator Bacte-	Dynamics.
	ria in Lake Kinneret.	W91-10861 2H
Legal System and Management of Southern	W91-11322 5B	Delay in John Bessyans Council by Internal
France Lagoons.	LAKE LANSING	Delay in Lake Recovery Caused by Internat Loading.
W91-10611 5G	Lake Lansing Dredging Evaluation Study, 1978-	W91-10886 2F
LAHARS	1984.	W 71-10000
Snow and Ice Perturbation during Historical	W91-10748 5G	Ion Concentrations in Interstitial Water as Indi
Volcanic Eruptions and the Formation of		cators for Phosphorus Release Processes and
Lahars and Floods.	LAKE MANAGEMENT	Reactions.
W91-11394 2C	Iterative Evaluation of a Lake Water Quality	W91-10888 2F
	Management Program.	Recent Sedimentation in Lake Michigan.
LAKE ACIDIFICATION	W91-10808 5G	W91-10976 2
History of Cladocera in the Kleiner Barsch-See,	Geomorphic, Geographic, and Hydrographic	
an Acidic, Calcium-Poor, Marshy Pond in the Middle European Flatland (Die Geschichte der	Basis for Resolving the Mono Lake Controver-	Acute Phototoxicity of Harbor and Tributary
Cladocerenfauna des Kleinen Barsch-Sees, eines	sy.	Sediments from Lower Lake Michigan.
Sauren, Kalkarmen Moorweihers im Mitteleuro-	W91-11442 6G	W91-10977 50
paischen Flachland).	LAKE MICHIGAN	Polychlorinated Biphenyls in Dated Sedimen
W91-11515 2H	Size Structure of Particulate Biogenic Silica in	C C C T T T T T T T T T T T T T T T T T
	Lake Michigan.	W91-10979 51
Diatom Analysis, Late-Glacial and Post-Glacial	W91-10975 2H	
Development of Lake Kleiner Barsch-See		Acoustic Parametric Array for Measuring th
(GDR)A Preliminary Note. W91-11517 2H	Recent Sedimentation in Lake Michigan.	Thickness and Stratigraphy of Contaminate Sediments.
W91-11517 2H	W91-10976 2J	W91-10981 2
Assessing the Response of Emerald Lake, an	Acute Phototoxicity of Harbor and Tributary	
Alpine Watershed in Sequoia National Park,	Sediments from Lower Lake Michigan.	Phosphorus from Internal Sources in the Lat
California, to Acidification during Snowmelt by	W91-10977 5C	rentian Great Lakes, and the Concept of Thresh
Using a Simple Hydrochemical Model.		old External Load.
W91-11594 5C	Polychlorinated Biphenyls in Dated Sediment	W91-10982 5
TAVE DACING	Cores from Green Bay and Lake Michigan.	Analysis of Subfossil Shelled Protozoa in th
LAKE BASINS Recent Sedimentation in Lake Michigan.	W91-10979 5E	Sediments of a Small Acid Forest Lake (Kleine
W91-10976 2J	LAKE OGUTA	Barsch-See, Northern GDR) (Analyse Subfo
W 21-102/0	Proximate Composition and Nutrient Elements	
Summer Circulation in the Kingston Basin, Lake		Kleinen Sauren Waldsees) (Kleiner Barsch-Se
Ontario.	Southern Nigeria.	Nordliche DDR).
W91-10978 2H	W91-11408 2H	W91-11516 2

2H

## LAKE SEDIMENTS

Chemical Composition of Late- and Post-Glacial Sediments (Fe, Mn, P, C, N, N, H and BSi) in Lake Kleiner Barsch-See, a Bog Lake in the	Three-Dimensional Numerical Modelling of Wind-Driven Circulation in a Shallow Homoge- neous Lake.	Land Use, Water Use, Streamflow Characteris- tics, and Water-Quality Characteristics of the Charlotte Harbor Inflow Area, Florida.
North of GDR (Die Chemische Zusammenset-	W91-10992 2H	W91-10771 4C
zung der Spat- und Postglazialsedimente des Kleinen Barsch-Sees (Fe, Mn, P, C, N, H und BSi), eines Dystrophen Moorweihers im Norden	Subice Layering and Origin of Acidic Waters in a Small Boreal Lake During the Spring Runoff.	Effect of Land Development on Groundwater Recharge Determined from Non-Steady Chlo-
der DDR). W91-11518 2H	W91-11229 5B	ride Profiles.
	In-Situ Sediment Oxygen Demand in Five	W91-10991 4C
LAKE SHORES Provincial Guidelines to Great Lakes Shoreline	Southwestern U.S. Lakes. W91-11333 2H	Critical Area Program of Maryland: Is it Clean- ing Up the Chesapeake Bay.
Management Plans. W91-11024 6E	LAND CLEARING	W91-11006 6B
LAKE TAHOE BASIN	Effect of Land Development on Groundwater Recharge Determined from Non-Steady Chlo-	Effects of Changes in Land Use on Annual
Phosphorus in the Truckee River Between Vista and Patrick, Storey and Washoe Counties,	ride Profiles. W91-10991 4C	Streamflows in the Lake Huron Basin of Canada and the United States. W91-11021 4C
Nevada, August 1984. W91-10763 5A	LAND DEVELOPMENT	Provincial Guidelines to Great Lakes Shoreline
LAKE WACCAMAW	Effects of Land Use Alteration on Tropical Carbon Exchange.	Management Plans.
Natural Phosphate Source for Lake Waccamaw, North Carolina, USA.	W91-11072 4C	W91-11024 6E
W91-11405 2H	LAND DISPOSAL	Micro-Targeting Cropland Retirement for Water Quality Improvement: Measuring the
LAKES	Development of Risk Assessment Methodology for Land Application and Distribution and Mar-	Benefits of Increased Information.
Potential Impacts of Climate Change on the Great Lakes.	keting of Municipal Sludge. W91-10708 5E	W91-11052 3F
W91-10480 2H	Production, Treatment and Handling of Sewage	Social and Private Returns from Wetland Pres- ervation.
Estimating the Effects on the Regional Precipi- tation Climate in a Semiarid Region Caused by	Sludge.	W91-11057 5G
an Artificial Lake Using a Mesoscale Model. W91-10502 2B	W91-11116 5D  Methods of Applying Sewage Sludge to Land:	Studies on Assessment of Water Balance and Its Quality in Gurpur River Basin, Karnataka State,
Secchi Disk and Photometer Estimates of Light Regimes in Alaskan Lakes: Effects of Yellow	A Review of Recent Developments. W91-11119 5E	India. W91-11065 5B
Color and Turbidity. W91-10860 2H	Removal of Heavy Metals from Sewage Sludge:	Effects of Land Use Alteration on Tropical
	State of the Art and Perspectives. W91-11124 5D	Carbon Exchange. W91-11072 4C
Role of Seasonal Turnover in Lake Alkalinity Dynamics.		Impact of Carbon Dioxide and Ammonium on
W91-10861 2H	Groundwater Contamination By Anthropogenic Organic Compounds From Waste Disposal	the Growth of Submerged Sphagnum cuspida-
Estimation of Phosphorus Exchange Between Littoral and Pelagic Zones During Nighttime Convective Circulation.	Sites: Transformations and Behavior. W91-11378 5B	tum. W91-11452 2H
W91-10863 2H	Agronomic Effects of Land Application of Water Treatment Sludges.	Budgets of Selected Cations and Anions in Two Forested Experimental Watersheds in Central
Shifts in Fish Vertical Distribution in Response to an Internal Seiche in a Stratified Lake.	W91-11459 4C	Greece. W91-11550 4C
W91-10864 2H	Nitrogen Dynamics of Pulp and Paper Sludge Amendment to Forest Soils.	
Microcystis Changes its Buoyancy in Response to the Average Irradiance in the Surface Mixed	W91-11510 5E	Land Tenure Issues in Watershed Development. W91-11569 6F
Layer. W91-10895 2H	LAND MANAGEMENT  Effect of Land Development on Groundwater	LANDFILLS Superfund Record of Decision. Mid-State Dis-
Ecophysiological Significance of the Diel Bio- chemical Changes of Particulates Coupled with	Recharge Determined from Non-Steady Chlo- ride Profiles.	posal Landfill, WI. W91-10749 5G
Metabolic and Environmental Parameters in	W91-10991 4C	Analysis of a Sanitary-Embankment Failure
Two Trophically Different Lakes. W91-10896 2H	LAND RECLAMATION Succession of Benthic Assemblages in Wild Bird Park, a Sanctuary Established on Reclaimed	Over the Rio de Janeiro Soft Clay Deposit. W91-10780 8D
Role of Phosphorus Cycling in Algal Metabo- lism and Algal Succession in Lake Donghu,	Land in Osaka Port.	Behavior of Double Geonet Drainage Systems.
China.	W91-10606 2L	W91-11096 5A
W91-10897 5C	Hydraulicking in Environmental Protection and Restoration.	Sewage Sludge Treatment and Use: New Devel-
Alternating Dynamics of Rotifers and Daphnia magna in a Shallow Lake.	W91-11283 5G	opments, Technological Aspects and Environ- mental Effects.
W91-10898 2H	Characteristics of Mining Quarries on Hydrau- lic-Fill Dumps.	W91-11115 5E
Riparian Zone as a Source of Phosphorus for a Groundwater-Dominated Lake.	W91-11286 8A	Physical and Chemical Characterization of Sewage Sludge.
W91-10931 2H	LAND TENURE	W91-11117 5D
Dynamic Model of Caesium Transport in Lakes and Their Catchments.	Land Tenure Issues in Watershed Development. W91-11569 6F	Environmental Aspects of Landfilling Sludge. W91-11136 5E
W91-10934 5B	LAND USE	
Great Lakes Total Phosphorus Model: Post Audit and Regionalized Sensitivity Analysis.	Urban Storm-Induced Discharge Impacts. W91-10745 5B	Sludge Recycling in Agriculture Compared with Other Disposal Methods in France. W91-11137 5E
W91-10974 2H	Effects of Land-Use Buffer Size on Spearman's	
Size Structure of Particulate Biogenic Silica in Lake Michigan.	Partial Correlations of Land Use and Shallow Ground-Water Quality.	Production of Compost from Sewage Sludge in Tokyo.
W91-10975 2H	W91-10761 4C	W91-11153 5E

Returnable Pesticide Containers: Maine's Depos- it and Collection System.	Deforestation and Leaching of Nitrogen as Ni- trates into Underground Water in Intertropical	Agency Autonomy in Transboundary Resource Management: The United States Section of the
W91-11191 5G	Zones: The Example of Cote d'Ivoire. W91-11446 2F	International Boundary and Water Commission, United States and Mexico.
Oregon Pesticide Container Initiative.	W 91-11440 2F	W91-11388 6E
W91-11192 5E	LEAD	W 91-11300
Waste Disposal Facilities and Community Re-	Patella vulgata, Mytilus minimus and Hyale pre-	Toxics Reduction: The Legal Framework.
sponse: Tracing Pathways from Facility Impacts	vosti as Bioindicators for Pb and Se Enrichment	W91-11538 6E
to Community Attitude.	in Alexandria Coastal Waters. W91-10875 5A	LEGIONELLA
W91-11280 5E	W 21-108/3	Most Probable Number Method for the Enu-
Groundwater Contamination By Anthropogenic	Distribution of Dissolved Cadmium, Lead and	meration of Legionella Bacteria in Water.
Organic Compounds From Waste Disposal	Copper in the Bristol Channel and the Outer	W91-10640 5A
Sites: Transformations and Behavior.	Severn Estuary. W91-10925 5B	O
W91-11378 5B	W 91-10923 3B	Occurrence of Legionella Bacteria in Cooling Towers in South Africa.
LANDSAT IMAGES	Selective Concentration of Lead(II) Chloride	W91-10641 5B
Visual Interpretation of a Landsat Mosaic of the	Complex With Liquid Anion-Exchange Mem-	***************************************
Okavango Delta and Surrounding Area.	branes. W91-11247 5D	Pulsed Field Electrophoresis of Genomic Re-
W91-10879 2H	W 51-11247 3D	striction Fragments for the Detection of Noso- comial Legionella pneumophila in Hospital
ATLAS*GRAPHICS: An Affordable Mapping	Modelling the Atmospheric Transport of Trace	Water Supplies.
System.	Metals Including the Role of Precipitating	W91-10836 5A
W91-11175 7C	Clouds. W91-11251 5B	
I ANDOVEDEC	W91-11231 3B	Incidence of Legionella in the Urban Environ-
LANDSLIDES September 5, 1987, Landslide on the La Grande	Concentration of Metals in Various Larval	ment in Australia. W91-10929 5B
River, James Bay, Quebec, Canada.	Stages of Four Ephemeroptera Species.	W91-10929
W91-10946 2J	W91-11302 5B	LEGISLATION
TARVAL CROWNING CTACE	Lead Sorption in Calcareous Soils.	Report of the River Master of the Delaware
LARVAL GROWTH STAGE Concentration of Metals in Various Larval	W91-11453 5B	River, for the Period December 1, 1988-Novem-
Stages of Four Ephemeroptera Species.	LEAKY AQUIFERS	ber 30, 1989. W91-10765 4A
W91-11302 5B	Method to Determine the Formation Constants	W91-10/03
T (INTERPRETATION	of Leaky Aquifers, and Its Application to Pump-	Will Free Trade Drink Canada Dry.
LAUNDERING Preliminary Data Summary for Industrial Laun-	ing Test Data.	W91-11041 6D
dries.	W91-10961 7C	Nonpoint Sources: Agenda for the Future.
W91-11093 5B	Environmental Isotope Study for Estimating	W91-11098 6E
TARREST THE PARTY OF TARREST AT	Leakage and Runoff of Ground Waters in the	W71-11070
LAWRENCE LIVERMORE NATIONAL LABORATORY	Xi'an Area.	Development of Environmental Control Legis
Remedial Investigation of the High Explosives	W91-10994 2F	lation and Effluent Standards for Australasias
Burn Pit Facility, Building 829 Complex, Law-	LEAVES	Wood Processing Industries. W91-11472 5G
rence Livermore National Laboratory Site 300.	Dry Deposition Washoff from Forest Tree	W 51-114/2
W91-10731 5B	Leaves by Experimental Acid Rainfall.	Toxics Reduction: The Legal Framework.
Soil Vapor Survey at the LLNL Site 300 Gener-	W91-10476 5B	W91-11538 6E
al Services Area, Adjacent Portions of the Con-	Processing of Leaves of Trees and Aquatic Ma-	LETHAL LIMIT
nolly and Gallo Ranches and the Site 300 Land-	crophytes in the Network of the River Rhone.	LC-50 Estimates and Their Confidence Intervals
fill Pit 6 Area.	W91-11402 2H	Derived for Tests with Only One Concentration
W91-10747 5B	LEGAL ASPECTS	with Partial Effect.
LEACHATES	Permitting Nonpoint Sources: Programs, Provi-	W91-10930 50
Measures for Purification of the Leachate from	sions, Problems and Potential.	LIBRARIES
'Renseanlaeg Damhusaen' into Copenhagen	W91-10730 5G	Establishment of a Groundwater Research Data
Waters, to Meet the NPO-Plan. W91-10601 5D	Negotiation Techniques to Resolve Western	Center for Validation of Subsurface Flow and
W 71-10001	Water Disputes.	Transport Models.
Permeability of Soils with Organic Fluids.	W91-10817 6E	W91-10736 21
W91-10783 5B	Critical Area Program of Maryland: Is it Clean-	LIFE HISTORY STUDIES
Leaching of Ammonium Nitrate under Field	ing Up the Chesapeake Bay.	Life Cycle Strategies of the Red Tide Causing
Conditions: Studies on Kinetics of Nitrification	W91-11006 6B	Flagellates Chattonella (Raphidophyceae) in th
and Nitrate Reduction in an Ultisol Profile.		Seto Inland Sea.
W91-10999 5B	Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes	W91-10546 51
Behavior of Double Geonet Drainage Systems.	and Failures.	LIGHT EFFECTS
W91-11096 5A	W91-11008 6E	Macrophyte Standing Crop and Primary Pro
Environmental Aspects of Landfilling Sludge.	Name of the Common Annual Control	ductivity in Some Florida Spring-Runs.
W91-11136 5E	Nonpoint Sources: Agenda for the Future. W91-11098 6E	W91-10812 21
	W 91-11096	Microcystis Changes its Buoyancy in Respons
Determination of Selenium Species in Spent Oil	Water Management in the 21st Century.	to the Average Irradiance in the Surface Mixe
Shale Leachates by Ion Chromatography. W91-11553 5B	W91-11206 4A	Layer.
	Groundwater Depletion in India: Institutional	W91-10895 2F
LEACHING	Management Regimes.	Comparative Study and Mathematical Modeling
Studies on the Environmental Persistence of S-	W91-11382 4B	of Temperature, Light and Growth of Thre
31183 (Pyriproxyfen): Adsorption onto Organic Matter and Potential for Leaching through Soil.	Tensions Between Water Legislation and Cus-	Microalgae Potentially Useful for Wastewate
W91-10831 5B	tomary Rights.	Treatment.
	W91-11383 6E	W91-10937 5I
Leaching of Ammonium Nitrate under Field	Danube River Basin: Negotiating Settlements to	Acute Phototoxicity of Harbor and Tributar
Conditions: Studies on Kinetics of Nitrification and Nitrate Reduction in an Ultisol Profile.	Transboundary Environmental Issues.	Sediments from Lower Lake Michigan.
W91-10999 5B	W91-11387 5G	W91-10977 56

### LIGHT PENETRATION

LIGHT PENETRATION	Ion Concentrations in Interstitial Water as Indi-	Sauren, Kalkarmen Moorweihers im Mitteleuro-
Optics of Little Sodus Bay.	cators for Phosphorus Release Processes and	paischen Flachland).
W91-10980 2H	Reactions. W91-10888 2K	W91-11515 2H
LIGNIN		Analysis of Subfossil Shelled Protozoa in the
Effect of NSSC Spent Liquor on Granule For- mation and Specific Microbial Activities In Upflow Anaerobic Reactors.	Microcystis Changes its Buoyancy in Response to the Average Irradiance in the Surface Mixed Layer.	Sediments of a Small Acid Forest Lake (Kleiner Barsch-See, Northern GDR) (Analyse Subfos- siler Protozoenschalen der Sedimente eines
W91-11482 5D	W91-10895 2H	Kleinen Sauren Waldsees) (Kleiner Barsch-See, Nordliche DDR).
Thermocatalytic and Chemical Treatment of	Ecophysiological Significance of the Diel Bio- chemical Changes of Particulates Coupled with	W91-11516 2H
Lignin-Aluminium Sludge and Utilization of the Resulting Adsorbent-Coagulant.	Metabolic and Environmental Parameters in	Chemical Composition of Late- and Post-Glacial
W91-11503 5D	Two Trophically Different Lakes. W91-10896 2H	Sediments (Fe, Mn, P, C, N, N, H and BSi) in Lake Kleiner Barsch-See, a Bog Lake in the
High-Performance Liquid Chromatographic	Role of Phosphory Cyclics in Alcel Motobs	North of GDR (Die Chemische Zusammenset-
Study on Oxidation Products of Lignin and Humic Substances.	Role of Phosphorus Cycling in Algal Metabo- lism and Algal Succession in Lake Donghu,	zung der Spat- und Postglazialsedimente des Kleinen Barsch-Sees (Fe, Mn, P, C, N, H und
W91-11513 5A	China. W91-10897 5C	BSi), eines Dystrophen Moorweihers im Norden
LIMESTONE		der DDR).
Design of Economic and Efficient Treatment Station for Acidic Streams.	Alternating Dynamics of Rotifers and Daphnia magna in a Shallow Lake.	W91-11518 2H
W91-11077 5G	W91-10898 2H	Microzoobenthos of the River Jihlava After the Construction of the Dalesice Waterworks.
Treatment of Waste Water From Wet	Great Lakes Total Phosphorus Model: Post	W91-11521 6G
Lime(Stone) Flue Gas Desulfurization Plants With Aid of Crossflow Microfiltration.	Audit and Regionalized Sensitivity Analysis. W91-10974 2H	Hydrobiological Survey of the Chanomi Creek System, Lower Niger Delta, Nigeria.
W91-11371 5D	Size Structure of Particulate Biogenic Silica in	W91-11524 5C
LIMITING NUTRIENTS	Lake Michigan.	Local and Seasonal Variation of the Epipelic
Criteria for Nutrient-Balanced Operation of Ac-	W91-10975 2H	Algae in Samarra Impoundment, Iraq.
tivated Sludge Process. W91-11493 5D	Recent Sedimentation in Lake Michigan. W91-10976 2J	W91-11525 2H
	W91-109/0	Impact of Physico-chemical Complexes on
LIMNOLOGY Features of the Limnological Behavior of Salto	Summer Circulation in the Kingston Basin, Lake Ontario.	Plankton Density in Dhir Beel of Assam. W91-11527 2H
Grande's Reservoir (Argentina-Uruguay). W91-10491 5C	W91-10978 2H	Seasonal Variations and Relationships of Differ-
	Optics of Little Sodus Bay.	ent Physico-chemical Characteristics in Newly
Species Composition of Fish Communities in Northern Wisconsin Lakes: Relation to pH.	W91-10980 2H	Made Tawa Reservoir. W91-11528 2H
W91-10725 5C	Phosphorus from Internal Sources in the Lau-	
Primary Productivity and Plankton Communi-	rentian Great Lakes, and the Concept of Thresh- old External Load.	Hydrologic Characteristics of the Great Salt Lake, Utah: 1847-1986.
ties in a Two-Reservoir Series. W91-10815 2H	W91-10982 5B	W91-11597 2H
Potential Effects of Global Warming on the	Three-Dimensional Numerical Modelling of	LINEAR ALKYL SULFONATES
Primary Productivity of a Subalpine Lake.	Wind-Driven Circulation in a Shallow Homoge- neous Lake.	Effects of Linear Alkylbenzene Sulphonate (LAS) on Skeletal Development of Sea Urchin
W91-10819 2H	W91-10992 2H	Embryos (Paracentrotus lividus LMK). W91-10891 5C
Aquatic Macroinvertebrates of the St. Francis	Effect of Hydroelectric Stations on Water Qual-	W 91-10891
Sunken Lands in Northeast Arkansas. W91-10844 4C	ity and Development of Phytoplankton in the Lower Pools of Reservoirs.	LINEAR ANALYSIS
Longitudinal Development of Macroinverte-	W91-11289 6G	Modeling Lake Erie as a Stochastic Linear Res- ervoir.
brate Communities Below Oligotrophic Lake	Influence of pH on Phosphate Release from	W91-11029 7C
Outlets.	Sediments.	LINGAYEN GULF
W91-10856 2H	W91-11327 2H	Water Quality Management Issues in Lingayen
Zooplankton Effects on Phytoplankton in Lakes	Multicomponent Kinetic Analysis of Iron Speci-	Gulf, Philippines and Some Proposed Solutions. W91-10523 5G
of Contrasting Trophic Status. W91-10859 2H	ation in Humic Lake Tjeukemeer: Comparison of Fulvic Acid from the Drainage Basin and	
	Lake Water Samples.	LIQUID CHROMATOGRAPHY
Secchi Disk and Photometer Estimates of Light	W91-11339 2H	Determination of Chlorinated Phenoxy Acid and Ester Herbicides in Soil and Water by
Regimes in Alaskan Lakes: Effects of Yellow Color and Turbidity.	Phosphorus Losses from the Epilimnion in	Liquid Chromatography Particle Beam Mass
W91-10860 2H	Rimov Reservoir.	Spectrometry and Ultraviolet Absorption Spec- trophotometry.
Role of Seasonal Turnover in Lake Alkalinity	W91-11401 2H	W91-10893 5A
Dynamics.	Natural Phosphate Source for Lake Waccamaw,	
W91-10861 2H	North Carolina, USA. W91-11405 2H	Liquid Chromatographic Determination of Gly- phosate and Aminomethylphosphonic Acid
Estimation of Phosphorus Exchange Between		(AMPA) in Environmental Water: Collaborative
Littoral and Pelagic Zones During Nighttime Convective Circulation.	Geographical and Pollenanalytical Research of Lake Kleiner Barsch-See (Bez. Potsdam, GDR)	Study. W91-11261 5A
W91-10863 2H	(Geographische und Pollenanalytische Untersuchungen des Kleinen Barsch-Sees) (Bez. Pots-	Comparison of Amperometric and UV-Spectro-
Shifts in Fish Vertical Distribution in Response	dam, DDR).	photometric Monitoring in the HPLC Analysis
to an Internal Seiche in a Stratified Lake.	W91-11514 2H	of Pesticides.
W91-10864 2H	History of Cladocera in the Kleiner Barsch-See,	W91-11306 5A
Delay in Lake Recovery Caused by Internal	an Acidic, Calcium-Poor, Marshy Pond in the	Multi-Residue-Analysis of Pesticides by HPLC
Loading.	Middle European Flatland (Die Geschichte der	after Solid Phase Extraction.

Application of HPLC Column-Switching in Pes-	Cave Environment in Wind Cave National Park,	MAGNETITE
ticide Residue Analysis.	South Dakota.	Magnetite Formation During Microbial Dissimi-
W91-11308 5A	W91-11389 7B	latory Iron Reduction.
and the second of the second s		W91-11544 2J
Behavior of the Fungicide MBAMT in Water.	Analysis and Interpretation of the Borehole	
W91-11315 5A	Televiewer Log: Information on the State of	MAHAWELI GANGA
LIQUID WASTES	Stress and the Lithostratigraphy at Hole 504B. W91-11549	Models of Seasonal Growth of the Equatorial
Liquid Effluents: New Solutions to Old Prob-	W 51-11349 /C	Carp Labeo dussumieri in Response to the River
lems.	LOS ANGELES	Flood Cycle. W91-11559 2H
W91-11360 5D	Marine Monitoring in Heterogeneous Environ-	W91-11559 2H
Study on Trial Manhaue Sanata (TMS)	ments.	MAINE
Study on Triple-Membrane-Separator (TMS) Process to Treat Aqueous Effluents Containing	W91-11264 5A	Returnable Pesticide Containers: Maine's Depos-
Uranium.	LOUISIANA	it and Collection System.
W91-11367 5D	Maps of the '400-foot,' '600-foot,' and Adjacent	W91-11191 5G
	Aquifers and Confining Beds, Baton Rouge	Kinetics of Chemical Weathering in B Horizon
LITERATURE REVIEW  Atrazine Hazards to Fish, Wildlife, and Inverte-	Area, Louisiana. W91-11086 2F	Spodosol Fraction.
brates: A Synoptic Review.	W91-11080 2F	W91-11233 5C
W91-10709 5C	Geohydrology and Simulation of Flow in the	2414 12041
	Chicot Aquifer System of Southwestern Louisi-	MALAYSIA  Assessment of Water Pollution using Diatom
Acid Precipitation: A Review.	ana.	Community Structure and Species Distribution—
W91-11074 5B	W91-11100 2F	A Case Study in a Tropical River Basin.
Sewage Treatment with Plants.	LOW FLOW	W91-11404 5C
W91-11466 5D	Secondary Salinization of Soils of the Dniester	
	Delta Floodplain.	MANAGEMENT PLANNING
Watershed Development in Asia: Strategies and	W91-10917 2G	National Program for Soil and Water Conserva-
Technologies. W91-11563 6B	LOW-HEAD HYDROELECTRIC PLANTS	tion. Its Effect on USDA Services.
W91-11303 0B	Experience with Low-Head HydroPlant Fre-	W91-11169 3F
Soil and Moisture Conservation Technologies:	quency Control.	Coordinating Roles and Services: Soil Conserva-
Review of Literature.	W91-11214 8C	tion Service and Extension Service.
W91-11565 4D	T NOR ADVERDO	W91-11171 6E
Land Tenure Issues in Watershed Development.	LYSIMETERS Production Functions Relating Crop Yield,	Desiries Comment Comment for Water Transfer
W91-11569 6F	Water Quality and Quantity, Soil Salintiy and	Decision Support System for Water Transfer Evaluation.
	Drainage Volume.	W91-11226 6A
Review of Fisheries Habitat Improvement	W91-11434 3C	W >1-11220
Projects in Warmwater Streams, with Recom-	A CONCENTED TEND A TEN	First Steps Toward Increasing the Reliability of
mendations for Wisconsin. W91-11591 2H	MACROINVERTEBRATES  Meiofauna of an Experimental Soft Bottom Eco-	Hydropower and Water-Management Facilities.
W 91-11391	systemEffects of Macrofauna and Cadmium	W91-11291 8A
LITHOSTRATIGRAPHY	Exposure.	Towards Management of Environmental Prob-
Analysis and Interpretation of the Borehole	W91-10519 5C	lems in Egypt.
Televiewer Log: Information on the State of Stress and the Lithostratigraphy at Hole 504B.	A	W91-11373 6G
W91-11549 7C	Aquatic Macroinvertebrates of the St. Francis Sunken Lands in Northeast Arkansas.	Water bad Davidson and in Asia, Stantanian and
W31-11343	W91-10844 4C	Watershed Development in Asia: Strategies and Technologies.
LITTER		W91-11563 6E
Man-Made Garbage Pollution on the Mediterra-	Macroinvertebrate Responses along a Complex	
nean Coastline. W91-10569 5B	Regulated Stream Environmental Gradient. W91-10848 4A	Framework for Planning, Monitoring, and Eval-
W 91-10309	W 91-10040 4A	uating Watershed Conservation Projects.
Effect of Coal-Mine Effluent on Fungal Assem-	Longitudinal Development of Macroinverte-	W91-11570 6E
blages and Leaf Breakdown.	brate Communities Below Oligotrophic Lake	MANGROVE SWAMPS
W91-11320 5C	Outlets.	Oil Spills in Mangroves: A Conceptual Mode
LITTORAL ZONE	W91-10856 2H	Based on Long-term Field Observations.
Estimation of Phosphorus Exchange Between	Impact of a Pulse Application of Permethrin on	W91-10489 5E
Littoral and Pelagic Zones During Nighttime	the Macroinvertebrate Community of a Head-	Seagrass-Mangrove Ecosystems Management: A
Convective Circulation.	water Stream.	Key to Marine Coastal Conservation in the
W91-10863 2H	W91-11456 5C	ASEAN Region.
LIVER	MACROPHYTES	W91-10539 50
Induction of Biotransformation in the Liver of	Macrophyte Standing Crop and Primary Pro-	Wetland Impoundments of East-Central Florida
Eel (Anguilla anguilla L.) by Sublethal Exposure	ductivity in Some Florida Spring-Runs.	W91-10854 2I
to Dinitro-o-cresol: An Ultrastructural and Bio-	W91-10812 2E	W 91-10034
chemical Study.	Ultrastructural and Biochemical Effects of Cad-	MANURE
W91-10826 5C	mium on the Aquatic Fern Marsilea minuta	New Developments in Processing of Sludge
Enhancement of Hepatocarcinogenesis in Rain-	Linn.	and Slurries.
bow Trout with Carbon Tetrachloride.	W91-10829 5C	W91-10699 5I
W91-11301 5C	Bioconcentration of Chlorinated Aromatic Hy-	Dutch Approach to Manure Processing.
LOCAL GOVERNMENTS	drocarbons in Aquatic Macrophytes.	W91-10703 5I
Transferability of Water Entitlements in Austra-	W91-11338 5B	M
lia.		Microbial Biomass and Biological Activities in
W91-10850 6E	Processing of Leaves of Trees and Aquatic Ma-	an Acid Sandy Soil Treated with Sewage Sludg or Farmyard Manure in a Long Term Field
Funding Groundwater Bratastian Brasses	crophytes in the Network of the River Rhone. W91-11402 2H	Experiment.
Funding Groundwater Protection Programs: Iowa's Groundwater Protection Fund.	W 21-11-02 211	W91-11160 51
W91-11179 5G	MAGNESIUM	
111 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Ozone, Acidic Precipitation, and Soil Mg Ef-	MAPPING
LOGGING (RECORDING)	fects on Growth and Nutrition of Loblolly Pine	ATLAS*GRAPHICS: An Affordable Mapping System.
Use of Electronic Data-Logging Equipment to	Seedlings. W91-10918 5C	W91-11175 76

# MAPPING

Application of the DRASTIC Mapping System for Evaluating Ground Water Pollution Poten-	Using Oil Spill Dispersants on the Sea. W91-10716 5G	Changes and Stress Signs in Plankton Communi- ties as a Result of Man-Induced Perturbations in
tial in Ohio. W91-11178 5B	Biotechnology Degradation and Mitigation of	Enclosed Coastal Seas (Mediterranean, Baltic). W91-10547 5C
Spatial Distribution of Precipitation Seasonality	Offshore Oil Spills, Phase 1. Main Report: Tech- nology to Enhance Biodegradation of Oil Spills	Long Term Ecological Changes in the Gulf of
in the United States. W91-11414 2B	State of the Art and Perspectives for Technolo-	Thailand. W91-10551 5B
	gy Development. W91-10735 5G	W91-10331
MAPS Maps of the '400-foot,' '600-foot,' and Adjacent	W71-10733	Effects of Oil Pollution on Bio-Ecology and
Aquifers and Confining Beds, Baton Rouge Area, Louisiana.	Voltammetric Determination of the Complexa- tion Parameters of Zinc in Marine and Estuarine	Fisheries on Certain Enclosed Coastal Regions of Arabian Sea.
W91-11086 2F	Waters. W91-10924 2K	W91-10555 5B
Availability of Ground Water from Unconsoli-		Simulation of Bioecological and Water Quality Processes in Enclosed Coastal Seas.
dated Deposits in the Mohawk River Basin, New York.	Mechanisms of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Dia- toms.	W91-10557 5C
W91-11104 2F	W91-11562 5C	Mariculture and Eutrophication in Jinhae Bay,
Hydrogeology of the Valley-Fill Aquifer at	MANUE VICINIDADE	Korea. W91-10558 5B
Owego, Tioga County, New York. W91-11105 2F	MARINE FISHERIES North Sea Strategies.	
	W91-10530 5G	Studies on the Situation of Pollution and Coun-
Application of the DRASTIC Mapping System for Evaluating Ground Water Pollution Poten-		termeasures of Control of the Oceanic Environ- ment in Zhoushan Fishing Ground: The Largest
tial in Ohio.	Change of Oceanic Condition by the Man-Made Structure for Upwelling.	Fishing Ground in China.
W91-11178 5B	W91-10542 8I	W91-10559 5C
Geologic Framework of the Columbia Plateau		Incidence and Ecology of Marine Fouling Orga-
Aquifer System, Washington, Oregon, and	Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.	nisms in the Eastern Harbour of Alexandria,
Idaho. W91-11571 2F	W91-10550 5G	Egypt. W91-10560 5C
	MARINE ORGANISMS	
Delineation of Flooding within the Ozark Na- tional Scenic Riverways in Southeastern Missou-	Pathways of Silver Uptake and Trophic Trans-	Study on Model Reference Adaptive Water Pol- lution Control in Enclosed Coastal Sea.
ri-Akers and Alley Spring.	fer in Estuarine Organisms.	W91-10567 5G
W91-11578 2E	W91-11337 5B	
Delineation of Flooding within the Ozark Na- tional Scenic Riverways in Southeastern Missou-	MARINE POLLUTION Runoff Characteristics of COD, BOD, C, N, and	Personal Computer System Supporting Water Quality Management in Eutrophicated Bay. W91-10582 5G
ri-Round Spring and Powder Mill.	P Loadings from Rivers to Enclosed Coastal	
W91-11579 2E	Seas.	Eutrophication Mechanisms of Coastal Seas in
Potential for Aquifer Recharge in Illinois (Ap-	W91-10521 5B	Yamaguchi Prefecture. W91-10593 5B
propriate Recharge Areas). W91-11580 7C	Pollution and Protection of Bohai Bay. W91-10522 5B	Water Quality Purification System for the En-
MARINAS	Water On the Manager to the Late	closed Sea Area.
Phenyltins in Water, Sediment, and Biota of	Water Quality Management Issues in Lingayen Gulf, Philippines and Some Proposed Solutions.	W91-10596 5G
Freshwater Marinas. W91-11342 5B	W91-10523 5G	Heavy Metals Contamination in the Polish Zone
*	Circulation and Ballatent Discouries in Massa	of Southern Baltic. W91-10597 5B
MARINE ANIMALS  Recovery of Aquatic Animals in Dokai Bay,	Circulation and Pollutant Dispersion in Masan- Jinhae Bay of Korea.	
Northern Kyushu, Japan.	W91-10526 5B	Pollutant Transport Monitoring and Prediction by Mathematical Modelling: North Sea and Ad-
W91-10550 5G	Numerical Simulation of Water Quality in	jacent Estuaries.
MARINE BACTERIA	Tokyo Bay.	W91-10600 5B
Annual Bacterial Production in Relation to	W91-10528 5B	East Asian Seas: Hypothetical Oil Spill Trajec-
Benthic Microalgal Production and Sediment Oxygen Uptake in an intertidal Sandflat and an	Field Survey and Hydraulic Study of 'Aoshio' in	tories.
Intertidal Mudflat.	Tokyo Bay.	W91-10608 5B
W91-10865 2L	W91-10529 5C	Fluxes and Transport of Anthropogenic and
MARINE BIOLOGY	North Sea Strategies.	Natural Polycyclic Aromatic Hydrocarbons in
Assimilation of Metals in Marine Copepods and	W91-10530 5G	the Western Mediterranean Sea. W91-10841 5B
its Biogeochemical Implications. W91-10866 2L	Water Quality Assessment and Protection Meas-	
	ures of a Semi-Enclosed Coastal Area: The Bay	Coefficient of Pollution (p): The Southern Cali- fornia Shelf and Some Ocean Outfalls.
MARINE CLIMATES Relation of Atmospheric CO2 to Tropical Sea	of Thermaikos (NE Mediterranean Sea).	W91-10874 5B
and Air Temperatures and Precipitation.	W91-10534 5G	Patella vulgata, Mytilus minimus and Hyale pre-
W91-11002 2B	Status of Eutrophication in the Great Barrier	vosti as Bioindicators for Pb and Se Enrichment
MARINE ENVIRONMENT	Reef Lagoon. W91-10535 5B	in Alexandria Coastal Waters.
Assessment of the Environmental Capacity of Enclosed Coastal Sea.		W91-10875 5A
W91-10571 5E	Eutrophication in Hiroshima Bay. W91-10536 5B	Tar Balls on Ibeno-Okposo Beach of South-East Nigeria.
Measures for Purification of the Leachate from	Heavy Metal Pollution in Sediment from the	W91-10876 5B
'Renseanlaeg Damhusaen' into Copenhagen Waters, to Meet the NPO-Plan.	Seto Inland Sea, Japan.	Volatile Organic Compounds in Two Polluted
W91-10601 5D	W91-10537 5B	Rivers in Barcelona (Catalonia, Spain). W91-10887 5B
Protective Effect of Glycine Betaine on Survival of Escherichia coli Cells in Marine Environ-	Summary of Ports and Marine Environment Im- provement Work and Example of Latest Meas-	Remobilization of Cu from Marine Particulate
ments.	ures in Seto Inland Sea.	Organic Matter and from Sewage.
W91-10637 5B	W91-10545 5G	W91-10923 5B

Oil Transport Management and Marine Pollu- tion Control: Oil Spill Prevention. W91-11081 5G	MASS SPECTROMETRY Determination of Chlorinated Phenoxy Acid and Ester Herbicides in Soil and Water by	Study on Model Reference Adaptive Water Pol- lution Control in Enclosed Coastal Sea. W91-10567 5G
Trace Element Distribution in Surficial Sedi-	Liquid Chromatography Particle Beam Mass Spectrometry and Ultraviolet Absorption Spec-	Environmental Information Processing of
ments of the Northern Tyrrhenian Sea: Contri- bution to Heavy-Metal Pollution Assessment.	trophotometry. W91-10893 5A	Closed Bay Area by Remote Sensing. W91-10581 7B
W91-11444 5A MARINE SEDIMENTS	Use of 2,2-Dimethoxypropane for the Direct	Personal Computer System Supporting Water
Fluidization of Marine Mud by Waves. W91-10533 5B	Gas Chromatographic-Mass Spectrometric De- termination of Some Organic Compounds in	Quality Management in Eutrophicated Bay. W91-10582 5G
Scavenging Processes of Marine Particles in	Water. W91-11245 5A	Pollutant Transport Monitoring and Prediction
Osaka Bay. W91-10538 5B	Determination of Trace Levels of Sulphate in Water Using Flow-Injection and In-Line Pre-	by Mathematical Modelling: North Sea and Ad- jacent Estuaries. W91-10600 5B
Annual Bacterial Production in Relation to	concentration. W91-11246 2K	East Asian Seas: Hypothetical Oil Spill Trajec-
Benthic Microalgal Production and Sediment Oxygen Uptake in an intertidal Sandflat and an	Multimethod for Pesticides in Soil at Trace	tories. W91-10608 5B
Intertidal Mudflat. W91-10865 2L	Level. W91-11309 5A	Dispersal Dynamics of Groundwater Bacteria.
Balance of Nutrient Losses and Gains in Sea-	MASSACHUSETTS	W91-10843 5B
grass Meadows.	Boston's Sewage Outfall.	Seasonal Influences on the Sediment Transport
W91-10867 2L	W91-10485 5D	Characteristics of the Sacramento River, Cali- fornia.
Chemical Composition of the Interstitial Water in Bottom Sediments of Tyrrhenian Sea (West-	Superfund Record of Decision: Iron Horse Park, MA.	W91-10847 2J
ern Mediterranean): Diagenetic Processes. W91-10880 2J	W91-10719 5G	Numerical Modelling of Vertical Ground Move- ments in Expansive Soils.
Organotin Stability During Storage of Marine	Role of Seasonal Turnover in Lake Alkalinity Dynamics.	W91-10945 2G
Waters and Sediments. W91-11255 5A	W91-10861 2H	Three-Dimensional Numerical Modelling of
	Road Salting Impacts in Massachusetts.	Wind-Driven Circulation in a Shallow Homoge- neous Lake.
Sulfur Enrichment of Humic Substances in a Delaware Salt Marsh Sediment Core.	W91-11053 4C	W91-10992 2H
W91-11258 2L	Willingness-to-Pay for Protection of Water Sup- plies in Four Massachusetts' Towns.	Atmospheric Carbon Dioxide and the Global
Trace Element Distribution in Surficial Sedi- ments of the Northern Tyrrhenian Sea: Contri-	W91-11056 6C	Carbon Cycle: The Key Uncertainties. W91-11068 5B
bution to Heavy-Metal Pollution Assessment. W91-11444 5A	Wellhead Protection in Massachusetts: Protect- ing Public Water Supplies from Pesticide Im-	Uncertainty in the Projection of Carbon Dioxide Emissions.
MARINE TRANSPORTATION	pacts. W91-11182 5G	W91-11069 5B
North Sea Strategies. W91-10530 5G	W91-11182 5G MATERIALS TESTING	Ambient Air Co-Modeling in Alaska.
MARSH MANAGEMENT	Behavior of Double Geonet Drainage Systems.	W91-11070 7C
Avalon Lakes: An Environmental Opportunity.	W91-11096 5A	Influence of Green Plants on the World Carbon Budget.
W91-11362 6G MARSH PLANTS	MATHEMATICAL EQUATIONS Preconditioned Conjugate-Gradient 2 (PCG2),	W91-11071 2K
Seasonal Variation of Biomass and Production	A Computer Program for Solving Ground- Water Flow Equations.	Effects of Land Use Alteration on Tropica
Dynamics for Above and Belowground Compo- nents of a Spartina alterniflora Marsh in the	W91-10764 7C	Carbon Exchange. W91-11072 40
Euhaline Sector of Paranagua Bay (SE Brazil).	Refinement of the Combination Equations for	Utility Planning Model for the Study of Air
W91-10495 2L	Evaporation. W91-11398 2K	Pollution Reduction. W91-11079 50
MARSHES  'Parque de Donana', and Its Contribution to	MATHEMATICAL MODELS	
Environmental Activities for Environmental Protection.	Organization of the Dynamic Network Struc- ture in the Dimension of Time.	Mathematical Modelling for Sulphur Dioxid Removal from Stack Gases in a Fluidized Bed o
W91-10586 5G	W91-10492 2H	Activated Sodium Carbonate. W91-11080 50
MARYLAND	Outflow and Three-Dimensional Spreading of	
Prospecting for Zones of Contaminated Ground- Water Discharge to Streams Using Bottom-Sedi-	River Water in Enclosed Bay. W91-10525 2L	Analytical Modeling of Aquifer Decontamina tion by Pumping When Transport is Affected by Rate-Limited Sorption.
ment Gas Bubbles. W91-10951 5B	Water Exchange and Transport of Matter in the	W91-11235 50
Critical Area Program of Maryland: Is it Clean-	Seto Inland Sea. W91-10527 2L	Response of Water Level in a Well to a Tim Series of Atmospheric Loading Under Confine
ing Up the Chesapeake Bay. W91-11006 6B	Numerical Simulation of Water Quality in	Conditions.
Maryland's Train-The-Trainer Program House-	Tokyo Bay. W91-10528 5B	W91-11236 21
hold Hazardous Waste. W91-11200 5G	5-Year Scientific Research Programme for Man-	Application of a Multiprocess Nonequilibrium Sorption Model to Solute Transport in a Strat
MASAN-JINHAE BAY	aging Coastal Seas. W91-10531 2L	fied Porous Medium. W91-11239 5
Circulation and Pollutant Dispersion in Masan-		
Jinhae Bay of Korea. W91-10526 5B		Efficiency With Which Drizzle and Precipit tion Sized Drops Collide With Aerosol Particle
MASS BALANCE	W91-10556 5C	W91-11252 2
Variability of Glacier Mass Balances in Western	Simulation of Bioecological and Water Quality Processes in Enclosed Coastal Seas.	Computation of Uniform Flow in Open Char nels with Flood Plains.
North America. W91-11391 2C		

### MATHEMATICAL MODELS

Soil Clean Up by In-situ Aeration: VI. Effects of Variable Permeabilities. W91-11317 5G	Acoustic Parametric Array for Measuring the Thickness and Stratigraphy of Contaminated Sediments.	Use of Ligand-Modified Micellar-Enhanced Ul- trafiltration in the Selective Removal of Metal Ions from Water.
	W91-10981 2J	W91-11318 5D
Empirical Method of Estimating Raingage and Radar Rainfall Measurement Bias and Resolu-	Automatic Tracer-Dilution Method Used for	Treatment of Bleach-Plant Effluents with Mem-
tion. W91-11409 2B	Stage-Discharge Ratings and Streamflow Hy- drographs on Small Iowa Streams.	brane Filtration and Sorption Techniques.
Persistent Patterns of Thunderstorm Activity in	W91-11111 7B	W91-11489 5D
the Central United States. W91-11411 2B	New Standards for the Determination of Geos- min and Methylisoborneol in Water by Gas	Membrane Filtration Combined with Biological Treatment for Purification of Bleach Plant Ef-
Soil Moisture: Empirical Data and Model Re-	Chromatography/Mass Spectroscopy. W91-11329 5A	fluents. W91-11490 5D
sults.		MEMBRANE PROCESSES
W91-11413 2G Four-Parameter Model for the Estimation of	Empirical Method of Estimating Raingage and Radar Rainfall Measurement Bias and Resolu-	MEMBRANE PROCESSES Fiscal Year 1988 Supported Liquid Membrane Development Report.
Rainfall Frequency in South-West England.	tion. W91-11409 2B	W91-10727 5G
W91-11415 2B	Multispectral Satellite Data in the Context of	Bubbleless Aeration.
Point-Infiltration Model for Estimating Runoff from Rainfall on Small Basins in Semiarid Areas	Land Surface Heat Balance.	W91-11222 5G
of Wyoming.	W91-11428 7B	Selective Concentration of Lead(II) Chloride
W91-11585 2E	MEDIAN TOLERANCE LIMIT	Complex With Liquid Anion-Exchange Mem-
MATHEMATICAL STUDIES	LC-50 Estimates and Their Confidence Intervals Derived for Tests with Only One Concentration	branes.
Computation of Average Seasonal Groundwater	with Partial Effect.	W91-11247 5D
Flows in Phreatic Aquifer-River System. W91-10910 2F	W91-10930 5C	Liquid Effluents: New Solutions to Old Prob- lems.
Self-Affine Scaling and Subsurface Response to	MEDITERRANEAN SEA Water Quality Assessment and Protection Meas-	W91-11360 5D
Snowmelt in Steep Terrain. W91-10912 2G	ures of a Semi-Enclosed Coastal Area: The Bay	Study on Triple-Membrane-Separator (TMS)
W91-10912 2G Similarity Solutions of the Shallow Water Equa-	of Thermaikos (NE Mediterranean Sea). W91-10534 5G	Process to Treat Aqueous Effluents Containing Uranium.
tions.	Changes and Stress Signs in Plankton Communi-	W91-11367 5D
W91-10987 8B	ties as a Result of Man-Induced Perturbations in	Application of Supported Liquid Membranes for
Diffusion in Fractal Porous Media. W91-11243 2F	Enclosed Coastal Seas (Mediterranean, Baltic). W91-10547 5C	Removal of Uranium From Groundwater. W91-11370 5G
MAUI	Eastern Mediterranean: A Marine Desert.	
Microclimatological Investigations in the Tropi-	W91-10553 2H	MERCURY Mercury Body Burden and Otolith Characteris-
cal Alpine Scrub of Maui, Hawaii: Evidence for a Drought-Induced Alpine Timberline.	Impact of Coastal Development on the Infralit-	tics of Bluefin Tuna from the Northwest Medi-
W91-10878 2I	toral Zone Along the Southeastern Mediterrane- an Shore of Continental France.	terranean (Balearic Sea). W91-10881 2L
MAXEY FLATS DISPOSAL SITE	W91-10562 6G	
Dendrogeomorphic Approach to Estimating	Man-Made Garbage Pollution on the Mediterra-	Assessment of Mercury Toxicity by the Changes
Slope Retreat, Maxey Flats, Kentucky. W91-11395 2D	nean Coastline. W91-10569 5B	in Oxygen Consumption and Ion Levels in the Freshwater Snail, Pila globosa, and the Mussel, Lamellidens marginalis.
MAXIMUM PROBABLE FLOODS		W91-11304 5C
Unit Hydrographs for Developing Design Flood	International Programme for the Protection of a Semi-Enclosed Sea: The Mediterranean Action	
Hydrographs. W91-10809 2E	Plan.	MESILLA BASIN Geohydrology and Simulation of Ground-Water
MAYFLIES	W91-10574 5G	Flow in the Mesilla Basin, Dona Ana County,
Concentration of Metals in Various Larval	Sewage Treatment and Disposal Strategies in	New Mexico, and El Paso County, Texas. W91-11088 2F
Stages of Four Ephemeroptera Species. W91-11302 5B	Greece. W91-10598 5G	
	Chemical Composition of the Interstitial Water	METABOLISM
MEASURING INSTRUMENTS  Comparison of Microwave Techniques for	in Bottom Sediments of Tyrrhenian Sea (West-	Bioaccumulation, Elimination and Metabolism of Triphenyltin Chloride by Early Life Stages of
Measuring Rainfall.	ern Mediterranean): Diagenetic Processes.	Minnows Phoxinus phoxinus.
W91-10499 2B	W91-10880 2J	W91-10877 5B
Observation of the Liquid Water Content of Melting Snowflakes with a New Instrument.	Mercury Body Burden and Otolith Characteris- tics of Bluefin Tuna from the Northwest Medi-	Role of Phosphorus Cycling in Algal Metabo- lism and Algal Succession in Lake Donghu,
W91-10516 2C	terranean (Balearic Sea). W91-10881 2L	China.
Direct Detection of Enteropathogenic Bacteria		W91-10897 5C
in Estuarine Water Using Nucleic Acid Probes.	MELTING Observation of the Liquid Water Content of	METAL COMPLEXES
W91-10664 5A Thermal-Pulse Flowmeter for Measuring Slow	Melting Snowflakes with a New Instrument. W91-10516 2C	Voltammetric Determination of the Complexa- tion Parameters of Zinc in Marine and Estuarine
Water Velocities in Boreholes.		Waters. W91-10924 2K
W91-10766 8G	MELVIN PRICE LOCKS  Melvin Price Locks and Dam Auxiliary Lock	
Determination of Subnanomolar Levels of	and Rotary Lock Culvert Valve, Mississippi	Measurement of the Different Forms of Zinc in Narragansett Bay Water Based on the Rate of
Iron(II) and Total Dissolved Iron in Seawater by Flow Injection Analysis with Chemilumines-	River, Alton, Illinois: Hydraulic Model Investi- gation.	Uptake by a Chelating Resin.
cence Detection.	W91-10723 8C	W91-10926 2K
W91-10773 2K	MEMBRANE FILTERS	Use of Ligand-Modified Micellar-Enhanced Ul-
Simple Design for Simultaneous Steady-State In-	Enumeration of Motile Aeromonas in Valencia	trafiltration in the Selective Removal of Metal
filtration Experiments with Ring Infiltrometers. W91-10813	Coastal Waters by Membrane Filtration. W91-10636 5B	Ions from Water. W91-11318 5D

Use of Ligand-Modified Micellar-Enhanced Ul-	and Plans of the Meteorological Component.	Microbial Dechlorination of the Herbicide Me-
trafiltration in the Selective Removal of Metal	W91-10943 2B	tolachlor.
Ions from Water. W91-11318 5D	Cloud/Cryosphere Interactions.	W91-11377 5B
	W91-11095 2B	MEXICO
METALS Assimilation of Metals in Marine Copepods and		Studies of Springs in the Southern Part of the
its Biogeochemical Implications.	Simulation of Precipitation by Weather Type Analysis.	Valley of Mexico (Estudio Crenologico en la Parte Meridional de la Cuenca de Mexico).
W91-10866 2L	W91-11230 2B	W91-11352 2E
Rapid Preconcentration Method for Multiele-		
ment Analysis of Natural Freshwaters.	Effect of Decoupled Low-Level Flow on Winter Orographic Clouds and Precipitation in	Agency Autonomy in Transboundary Resource Management: The United States Section of the
W91-10892 7B	the Yampa River Valley.	International Boundary and Water Commission,
Groundwater Flow and the Metal Content of	W91-11410 2B	United States and Mexico.
Peat.	Desired Dates of Thursday Astricts in	W91-11388 6E
W91-10902 2F	Persistent Patterns of Thunderstorm Activity in the Central United States.	MICROBIAL DEGRADATION
Toxicity of Metals to a Freshwater Tubificid	W91-11411 2B	Biodegradation of Chemicals at Trace Concen-
Worm, Tubifex tubifex (Muller).	0 1 0 1000 D 1	trations. W91-11102 5B
W91-11303 5C	Spring and Summer 1988 Drought over the Contiguous United StatesCauses and Predic-	W91-11102 3B
Use of Ligand-Modified Micellar-Enhanced Ul-	tion.	Microbial Dechlorination of the Herbicide Me-
trafiltration in the Selective Removal of Metal	W91-11412 2B	tolachlor. W91-11377 5B
Ions from Water. W91-11318 5D	Four-Parameter Model for the Estimation of	W91-113//
W91-11318 5D	Rainfall Frequency in South-West England.	Processing of Leaves of Trees and Aquatic Ma-
METAZACHLOR	W91-11415 2B	crophytes in the Network of the River Rhone. W91-11402 2H
Development of an Enzyme Immunoassay for the Determination of Metazachlor.	0	W91-11402 2n
W91-11295 5A	Spatial Distribution of Rainfall in the Greater Athens Area.	Magnetite Formation During Microbial Dissimi-
	W91-11416 2B	latory Iron Reduction. W91-11544 2J
METEOROLOGICAL DATA Estimation of the Mean Field Bias of Radar		W71-11344
Rainfall Estimates.	Kinematic, Dynamic, and Thermodynamic Analysis of a Weakly Sheared Severe Thunder-	MICROBIAL INSECTICIDES
W91-10857 2B	storm over Northern Alabama.	Use of Bacillus thuringiensis var. israelensis to
Canadian Atlantic Storms Program: Progress	W91-11417 2B	Control the Nuisance Fly Sylvicola fenestralis (Anisopodidae) in Sewage Filter Beds.
and Plans of the Meteorological Component.	No. of the Control of the Production of the	W91-10890 5D
W91-10943 2B	Numerical Simulations of the Evolution of a Cold Front and its Precipitation.	MICROBIAL MATS
Precipitation in Britain: An Analysis of Area-	W91-11418 2B	Microbial Mats in Tidal Channels at San Carlos,
Average Data Updated to 1989.		Baja California Sur, Mexico.
W91-10973 2B	Satellite-Derived Integrated Water-Vapor Dis- tribution in Oceanic Midlatitude Storms: Varia-	W91-11400 2L
Spatial Distribution of Rainfall in the Greater	tion with Region and Season.	MICROBIOLOGICAL STUDIES
Athens Area.	W91-11419 2B	Health-Related Water Microbiology 1990.
W91-11416 2B	Complete to Southern Complete Winnerston	W91-10612 5F
METEOROLOGICAL DATA COLLECTION	Squall Line in Southern Germany: Kinematics and Precipitation Formation as Deduced by Ad-	Microbiological Methods for Safety Testing of
Squall Line in Southern Germany: Kinematics	vanced Polarimetric and Doppler Radar Meas-	Drinking Water Directly Reclaimed from
and Precipitation Formation as Deduced by Ad- vanced Polarimetric and Doppler Radar Meas-	urements.	Wastewater.
urements.	W91-11420 2B	W91-10613 5A
W91-11420 2B	Sensitivity Studies of Tropical Storm Genesis	Destruction of Faecal Bacteria, Enteroviruses
Convective Cell in a Hurricane Rainband.	Using a Numerical Model.	and Ova of Parasites in Wastewater Sludge by
W91-11422 2B	W91-11421 2B	Aerobic Thermophilic and Anaerobic Mesophi- lic Digestion.
Assessment of MAS Desired Retrievels and De	Convective Cell in a Hurricane Rainband.	W91-10688 5D
Assessment of VAS-Derived Retrievals and Parameters used in Thunderstorm Forecasting.	W91-11422 2B	Comparison Patruson Model Simulations and
W91-11423 2B	Assessment of VAS-Derived Retrievals and Pa-	Comparison Between Model Simulations and Field Results for In-Situ Biorestoration of Chlor-
Multispectral Satellite Data in the Context of	rameters used in Thunderstorm Forecasting.	inated Aliphatics: Part 1. Biostimulation of
Land Surface Heat Balance.	W91-11423 2B	Methanotrophic Bacteria. W91-10955 5G
W91-11428 7B	Dimensional Foreign and Marcanala Organization	W91-10933
METEOROLOGY	Dynamical Forcing and Mesoscale Organization of Precipitation Bands in a Midwest Winter Cy-	Mechanisms of Resistance to Polychlorinated
Research on Clouds and Precipitation: Past,	clonic Storm.	Biphenyls (PCB) in Two Species of Marine Dia-
Present and Future, Part II.	W91-11424 2B	toms. W91-11562 5C
W91-10481 3B	METHANE	
Estimating the Effects on the Regional Precipi-	Abbeystead Outfall Works: Background to Re-	MICROCLIMATOLOGY Microclimatological Investigations in the Tropi-
tation Climate in a Semiarid Region Caused by	pairs and Modifications and Lessons Learned.	cal Alpine Scrub of Maui, Hawaii: Evidence for
an Artificial Lake Using a Mesoscale Model. W91-10502 2B	W91-11355 5D	a Drought-Induced Alpine Timberline.
	METHANE BACTERIA	W91-10878 2I
Electrical and Kinematic Structure of the Strati-	Comparison Between Model Simulations and	MICROFILTRATION
form Precipitation Region Trailing an Oklahoma Squall Line.	Field Results for In-Situ Biorestoration of Chlor-	Treatment of Waste Water From Wet
W91-10514 2B	inated Aliphatics: Part 1. Biostimulation of Methanotrophic Bacteria.	Lime(Stone) Flue Gas Desulfurization Plants
	W91-10955 3G	With Aid of Crossflow Microfiltration. W91-11371 5D
Meteorology and Oceanography in the Seto Inland Sea.		777
W91-10520 2L	METHANOGENESIS	MICROORGANISMS
Casa Studies in Data Analusis	Anaerobic Biodegradability and Methanogenic Toxicity of Pulping Wastewaters.	Use of Risk Assessment for Development of Microbial Standards.
Case Studies in Data Analysis. W91-10733 2B	W91-11480 5D	W91-10619 5G

### MICROORGANISMS

Surveillance Solutions to Microbiological Prob- lems in Water Quality Control in Developing Countries. W91-10625 5G	MINERALS Ground-Water Control of Evaporite Deposition. W91-11438 2K	MODEL STUDIES Uncertainty Analysis for a Linear Programming Model for Acid Rain Abatement. W91-10470 7C
	MINING ENGINEERING	W91-104/0
Application of Microbial Tracers in Groundwater Studies.	Characteristics of Mining Quarries on Hydrau- lic-Fill Dumps.	Properties of Linear Programming Models for Acid Rain Abatement.
W91-10671 5B	W91-11286 8A	W91-10477 5G
Field Experiments with Microbiological Tracers	MINNESOTA	Perspectives for Ecological Modelling of Tropi-
in a Pore Aquifer. W91-10673 5B	Minnesota District, Water Resources Division: Information and Technical Assistance.	cal and Subtropical Reservoirs in South America.
	W91-11167 2F	W91-10487 2H
Transport of Microorganisms in the Under- ground: Processes, Experiments and Simulation	Minnesota Clean Water Partnership Program.	
Models.	W91-11181 5G	Mathematical Simulation of Pollutant Disper-
W91-10674 5B		sion. W91-10488 5B
Contribution for the Study of New Bothsonia	Minnesota's Olmsted County: A Cooperative Health Based Perspective on Zoning and Plan-	W 21-10400
Contribution for the Study of New Pathogenic Indicators Removal from W. S. P. in Portugal.	ning.	Oil Spills in Mangroves: A Conceptual Model
W91-10689 5D	W91-11187 6B	Based on Long-term Field Observations. W91-10489 5B
I	Minnesota Waste Pesticide Collection Pilot	W91-10489 5B
Improvement of the Quality of Sewage Sludge: Microbiological Aspects.	Project.	Mathematical Modelling for Reservoir Water-
W91-11125 5D	W91-11193 5E	Quality Management Through Hydraulic Struc-
	The Profile War of the Control	tures: A Case Study. W91-10490 5G
Biological Bleaching of Wood Pulps-A Viable	Urban Pesticide Waste Management: Strategies for Education and Collection.	W91-10490 5G
Chlorine-Free Bleaching Technology. W91-11476 5G	W91-11194 5E	Organization of the Dynamic Network Struc-
		ture in the Dimension of Time.
MICROSCOPIC ANALYSIS	Pesticide Rinseate Management Plan.	W91-10492 2H
Induction of Biotransformation in the Liver of Eel (Anguilla anguilla L.) by Sublethal Exposure	W91-11195 5G	Effect of Coastal Sea Level Forcing on Indian
to Dinitro-o-cresol: An Ultrastructural and Bio-	MINNESOTA RIVER	River Bay and Rehoboth Bay, Delaware.
chemical Study.	Monthly Mean Discharge at and Between Se-	W91-10494 2L
W91-10826 5C	lected Streamflow-Gaging Stations Along the	Estimating the Effects on the Besievel Bessiel
MICROWAVES	Mississippi, Minnesota, and St. Croix Rivers, 1932-87.	Estimating the Effects on the Regional Precipi- tation Climate in a Semiarid Region Caused by
Comparison of Microwave Techniques for	W91-10760 2E	an Artificial Lake Using a Mesoscale Model.
Measuring Rainfall.		W91-10502 2B
W91-10499 2B	MINNOWS  Bioaccumulation, Elimination and Metabolism of	Advances in Wind and Water Erosjon Predic-
Microwave Transmission, a New Tool in Forest	Triphenyltin Chloride by Early Life Stages of	tion.
Hydrological Research.	Minnows Phoxinus phoxinus.	W91-10509 2J
W91-10995 2I	W91-10877 5B	
Classification of Snow Cover and Precipitation	Upstream Extirpation of Four Minnow Species	WEPP: Soil Erodibility Experiments for Range- land and Cropland Soils.
Using the Special Sensor Microwave Imager.	Due to Damming of a Prairie Stream.	W91-10512 2J
W91-11219 7B	W91-11535 6G	
MIDGES	MISSISSIPPI RIVER	Three-Dimensional Simulation of Airflow and
Production of Chironomid Larvae in Culturing	Melvin Price Locks and Dam Auxiliary Lock	Orographic Rain Over the Island of Hawaii. W91-10517 2B
Media of Various Organic Wastes.	and Rotary Lock Culvert Valve, Mississippi	1171-10317
W91-11526 8I	River, Alton, Illinois: Hydraulic Model Investi-	Outflow and Three-Dimensional Spreading of
MILITARY RESERVATIONS	gation. W91-10723 8C	River Water in Enclosed Bay. W91-10525 2L
Long Climb to Remediation.	W >1-10/23	W91-10323
W91-10483 5G	Monthly Mean Discharge at and Between Se-	Circulation and Pollutant Dispersion in Masan-
MILK RIVER	lected Streamflow-Gaging Stations Along the Mississippi, Minnesota, and St. Croix Rivers,	Jinhae Bay of Korea.
Milk River: Historical Transitions in an Interna-	1932-87.	W91-10526 5B
tional Waterway.	W91-10760 2E	Water Exchange and Transport of Matter in the
W91-11039 6E	Evaluation of Three Scenarios of Ground-Water	Seto Inland Sea.
MINE WASTES	Withdrawal from the Mississippi River Alluvial	W91-10527 2L
Assignment of the Class of Hydraulic-Fill Waste	Aquifer in Northwestern Mississippi.	Numerical Simulation of Water Quality in
Dumps.	W91-11106 4B	Tokyo Bay.
W91-11285 5E	MISSOURI	W91-10528 5B
Effect of Coal-Mine Effluent on Fungal Assem-	Precipitation Changes in Fall, Winter, and	5-Year Scientific Research Programme for Man-
blages and Leaf Breakdown.	Spring Caused by St Louis.	aging Coastal Seas.
W91-11320 5C	W91-10500 2B	W91-10531 2L
Removal of Heavy Metals and Other Cations	Delineation of Flooding within the Ozark Na-	Ecological Modelling at Osaka Bay Related to
From Wastewater Using Zeolites.	tional Scenic Riverways in Southeastern Missou-	Long-Term Eutrophication.
W91-11369 5D	ri-Akers and Alley Spring.	W91-10556 5C
226-Ra and Other Radionuclides in Water,	W91-11578 2E	Simulation of Bioecological and Water Quality
Vegetation, and Tissues of Beavers (Castor cana-	MISSOURI RIVER BASIN	Processes in Enclosed Coastal Seas.
densis) from a Watershed Containing U Tailings	Removal of Biota from Inter-Basin Transfer	W91-10557 5C
Near Elliot Lake, Canada. W91-11454 5B	Water.	
W91-11454 5B	W91-11017 5F	Study on Model Reference Adaptive Water Pol- lution Control in Enclosed Coastal Sea.
MINERALIZATION	MIXING	W91-10567 5G
Ion Concentrations in Interstitial Water as Indi-	Influence of Reactor Mixing Characteristics on	
cators for Phosphorus Release Processes and Reactions.	the Rate of Nitrification in the Activated Sludge Process.	Environmental Information Processing of Closed Bay Area by Remote Sensing.
W91-10888 2K	W91-10932 5D	W91-10581 7E

Pollutant Transport Monitoring and Prediction by Mathematical Modelling: North Sea and Ad-	Dispersal Dynamics of Groundwater Bacteria. W91-10843 5B	Great Lakes Total Phosphorus Model: Post Audit and Regionalized Sensitivity Analysis.
jacent Estuaries. W91-10600 5B	Seasonal Influences on the Sediment Transport	W91-10974 2H
Flow Control Technology for Enhancement and	Characteristics of the Sacramento River, Cali- fornia.	Analysis of Large Scale Water Distribution Sys- tems.
Diverse Use of the Marine Environment. W91-10607 2L	W91-10847 2J	W91-10983 5F
	Off-River Storages as Sources and Sinks for Environmental Contaminants.	Three-Dimensional Numerical Modelling of
East Asian Seas: Hypothetical Oil Spill Trajectories.	W91-10851 5B	Wind-Driven Circulation in a Shallow Homoge- neous Lake.
W91-10608 5B	Sorption Phenomena in Subsurface Systems:	W91-10992 2H
Computer Visualization System for Sediment	Concepts, Models, and Effects on Contaminant Fate and Transport.	Boundary Element and Particle Tracking Model
Pollution in Japan. W91-10609 7C	W91-10882 5B	for Advective Transport in Zoned Aquifers. W91-10997 2F
Melvin Price Locks and Dam Auxiliary Lock	Groundwater Management Model for Salt Lake	
and Rotary Lock Culvert Valve, Mississippi River, Alton, Illinois: Hydraulic Model Investi-	County, Utah with Some Water Rights and Water Quality Considerations.	Discrete-Kernel Method for Simulating Pump- ing Tests in Large-Diameter Wells.
gation.	W91-10911 4B	W91-10998 2F
W91-10723 8C	Self-Affine Scaling and Subsurface Response to	Oil Spill Risk Simulation Model.
In-Flow Vibrations of Gate Edges. W91-10724 8B	Snowmelt in Steep Terrain. W91-10912 2G	W91-11001 5E
		Changing Dynamics of Interest Representation
Zonal Average Cloud Characteristics for Global Atmospheric Chemistry Modelling.	Dynamic Simulation of Storm Tanks. W91-10928 5D	in Water Resources Management. W91-11007 6E
W91-10728 2B	Humic Substances in Acid Surface Waters;	
Establishment of a Groundwater Research Data	Modelling Aluminium Binding, Contribution to	Political Economic Model of International Pol- lution.
Center for Validation of Subsurface Flow and Transport Models.	Ionic Charge-Balance, and Control of pH. W91-10933 5C	W91-11016 5E
W91-10736 2F		Great Lakes Levels and Flows Under Natura
Investigation of Local Scour in Cohesionless	Dynamic Model of Caesium Transport in Lakes and Their Catchments.	and Current Conditions. W91-11022 2F
Sediments Using a Tunnel-Model. W91-10746 2J	W91-10934 5B	
	Comparative Study and Mathematical Modeling	Modeling Lake Erie as a Stochastic Linear Res ervoir.
Preconditioned Conjugate-Gradient 2 (PCG2), A Computer Program for Solving Ground-	of Temperature, Light and Growth of Three Microalgae Potentially Useful for Wastewater	W91-11029 70
Water Flow Equations.	Treatment.	Evaluating the Impact of Water Quality Upo
W91-10764 7C	W91-10937 5D	the Value of Recreational Fishing. W91-11058
Analysis of Three-Dimensional Ground Move- ments: The Thunder Bay Tunnel.	Comparison Between Model Simulations and Field Results for In-Situ Biorestoration of Chlor-	
W91-10775 8A	inated Aliphatics: Part 1. Biostimulation of	Atmospheric Carbon Dioxide and the Globe Carbon Cycle: The Key Uncertainties.
Finite-Element Analysis of Softening Effects in	Methanotrophic Bacteria. W91-10955 5G	W91-11068 51
Fissured, Overconsolidated Clays and Mud- stones.	Delineation of Traveltime-Related Capture	Uncertainty in the Projection of Carbon Dioxid
W91-10776 8D	Areas of Wells Using Analytical Flow Models	Emissions. W91-11069 5
Computer Modeling of Scale Formation During	and Particle-Tracking Analysis. W91-10957 2F	
Treatment of Ground Water in Air Strippers. W91-10798 5G	Method to Determine the Formation Constants	Ambient Air Co-Modeling in Alaska. W91-11070 76
	of Leaky Aquifers, and Its Application to Pump-	Influence of Green Plants on the World Carbo
Modelling Water and Solute Transport in Ma- croporous Soil. I. Model Description and Sensi-	ing Test Data. W91-10961 7C	Budget.
tivity Analysis.	Hydrological Balance of Two Mediterranean	W91-11071 21
	Forested Catchments (Prades, Northeast Spain).	Effects of Land Use Alteration on Tropics
Modelling Water and Solute Transport in Ma- croporous Soil. II. Chloride Breakthrough	W91-10963 2A	Carbon Exchange. W91-11072 4
Under Non-Steady Flow.	Effects of Climate Change on Discharges and Snow Cover in Finland.	Utility Planning Model for the Study of A
W91-10804 2G	W91-10964 2C	Pollution Reduction.
Model of Ammonia Volatilization From Applied Urea. V. The Effects of Steady-State Drainage	Maximum Entropy View of Probability-Distrib-	W91-11079 50
and Evaporation.	uted Catchment Models.	Mathematical Modelling for Sulphur Dioxid
W91-10805 3F	W91-10965 2A	Removal from Stack Gases in a Fluidized Bed Activated Sodium Carbonate.
Model of Ammonia Volatilization From Applied Urea. VI. The Effects of Transient-State Water	Runoff Analysis of the Chang Jiang (The Yangtze River).	W91-11080 56
Evaporation.	W91-10966 2E	Relationship of Regional Water Quality to Aqu
W91-10806 3F	Dynamic-Stochastic Models of Rainfall and	fer Thermal Energy Storage. W91-11082
Water Use Reductions from Retrofitting Indoor Water Fixtures.	Snowmelt Runoff Formation. W91-10967 2A	
W91-10811 6D		Energy Transformation-Ecology Interface fro a Nonlinear, Nonequilibrium Thermodynam
Buffer Strips to Protect Water Supply Reser-	Dynamic Simulation Model of Vertical Infiltra- tion of Water in Soil.	Perspective.
voirs: A Model and Recommendations. W91-10816 5G	W91-10968 2A	W91-11085
	Some Updated Statistical Assessments of the	Geohydrology and Simulation of Ground-Wat Flow in the Mesilla Basin, Dona Ana Count
Potential Effects of Global Warming on the Primary Productivity of a Subalpine Lake.	Surface Temperature Response to Increased Greenhouse Gases.	New Mexico, and El Paso County, Texas.
W91-10819 2H	W91-10969 2B	W91-11088

### MODEL STUDIES

Analysis of Ground-Water Flow in the A-Sand Aquifer at Paramaribo, Suriname, South Amer- ica.	Numerical Simulations of the Evolution of a Cold Front and its Precipitation. W91-11418	Phosphorus in the Truckee River Between Vista and Patrick, Storey and Washoe Counties, Nevada, August 1984.
W91-11090 2F	W91-11416 2B	W91-10763 5A
Techniques for Estimation of Storm-Runoff	Sensitivity Studies of Tropical Storm Genesis	
Loads, Volumes, and Selected Constituent Con- centrations in Urban Watersheds in the United	Using a Numerical Model. W91-11421 2B	Cone Penetrometer Tests and HydroPunch Sampling: A Screening Technique for Plume Definition.
States. W91-11094 5B	Approaches to the Simulation of Regional Cli- mate Change: A Review.	W91-10794 5A
	W91-11427 5C	Field Sampling of Residual Aviation Gasoline in
Geohydrology and Simulation of Flow in the Chicot Aquifer System of Southwestern Louisi-	Ground-Water Control of Evaporite Deposition.	Sandy Soil.
ana. W91-11100 2F	W91-11438 2K	W91-10795 5A
	Estimating Flow Characteristics at Ungauged	Occurrence of Appendix IX Organic Constitu-
Calibration of a Texture-Based Model of a Ground-Water Flow System, Western San Joa-	Sites.	ents in Disposal Site Ground Water. W91-10801 5B
quin Valley, California.	W91-11545 2E	
W91-11101 5B	Interpretation of Hydrologic Effects of Climate	Behavior of Double Geonet Drainage Systems. W91-11096 5A
Transport and Fate of Acetone in an Outdoor	Change in the Sacramento-San Joaquin River	
Model Stream, Stennis Space Center near Bay St. Louis, Mississippi.	Basin, California. W91-11552 5C	Marine Monitoring in Heterogeneous Environ- ments.
W91-11103 5B		W91-11264 5A
Executive Summary-Assessing the Response of	Models of Seasonal Growth of the Equatorial Carp Labeo dussumieri in Response to the River	
Emerald Lake, An Alpine Watershed in Sequoia	Flood Cycle.	Strategy for Pesticide Control in Ground Water and Drinking Water.
National Park, California, to Acidification	W91-11559 2H	W91-11312 5A
During Snowmelt Using a Simple Hydrochemi- cal Model.	Characterization and Simulation of Rainfall-	Manitoring of Organishlarine Company In
W91-11112 7C	Runoff Relations for Headwater Basins in West-	Monitoring of Organochlorine Compounds In Finnish Inland Waters Polluted by Pulp and
Planned Studies of Agrichemicals in Ground	ern King and Snohomish Counties, Washington.	Paper Effluents Using the Mussel Incubation
and Surface Water in the Mid-Continental	W91-11592 2A	Method.
United States. W91-11168 5B	Assessing the Response of Emerald Lake, an	W91-11507 5A
	Alpine Watershed in Sequoia National Park, California, to Acidification during Snowmelt by	Trends in Water-Quality Data in Texas.
Simulation of Precipitation by Weather Type Analysis.	Using a Simple Hydrochemical Model.	W91-11593 5B
W91-11230 2B	W91-11594 5C	Evaluation of Site-Selection Criteria, Well
Application of a Multiprocess Nonequilibrium	MOHAWK RIVER BASIN	Design, Monitoring Techniques, and Cost Anal-
Sorption Model to Solute Transport in a Strati-	Availability of Ground Water from Unconsoli-	ysis for a Ground-Water Supply in Piedmont Crystalline Rocks, North Carolina.
fied Porous Medium.	dated Deposits in the Mohawk River Basin, New York.	W91-11596 2F
W91-11239 5B	W91-11104 2F	MONITORING WELLS
Modelling the Atmospheric Transport of Trace Metals Including the Role of Precipitating	MOISTURE STRESS	Installation of the Westbay Multiport Ground-
Clouds.	Effects of Drought Stress and Simulated Acidic	Water Sampling System in Well 699-43-42K Near The 216-B-3 Pond.
W91-11251 5B	Rain on Foliar Conductance of Zea mays L.	W91-10720 7B
Aquatic Habitat Measurement and Valuation:	W91-10919 5C	77.77 A. W. W. L. G L
Imputing Social Benefits to Instream Flow	MOLLUSKS	Utility of Multiple-Completion Monitoring Wells for Describing a Solvent Plume.
Levels. W91-11266 7C	Construction of Artificial Seaweed Bed Accom- panied with the Reclamation for Unit No. 3 of	W91-10800 7A
Risk-based Performance Criteria for Real-time	Ikata Power Station.	MONO LAKE
Reservoir Operation.	W91-10603 2L	Geomorphic, Geographic, and Hydrographic
W91-11275 4A	MONITORING	Basis for Resolving the Mono Lake Controver-
Computation of Uniform Flow in Open Chan-	Measurement of the Effect of Organic Pollution	sy. W91-11442 6G
nels with Flood Plains. W91-11281 2E	on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers.	
	W91-10469 5A	MONSOONS  East Asian Seas: Hypothetical Oil Spill Trajec-
Soil Clean Up by In-situ Aeration: VI. Effects of Variable Permeabilities.	Statistical Analysis of Errors in Estimating Wet	tories.
W91-11317 5G	Deposition Using Five Surface Estimation Algo-	W91-10608 5B
Modeling the Upflow Anaerobic Sludge Bed-	rithms.	Computation of Average Seasonal Groundwater
Filter System: a Case with Hysteresis.	W91-10474 7B	Flows in Phreatic Aquifer-River System.
W91-11321 5D	Water Quality Assessment and Protection Meas-	W91-10910 2F
Simplified Phosphorus Trophic State Model for	ures of a Semi-Enclosed Coastal Area: The Bay of Thermaikos (NE Mediterranean Sea).	MONTANA
Warm-Water Tropical Lakes.	W91-10534 5G	Milk River: Historical Transitions in an Interna-
W91-11332 5C	Pollutant Transport Monitoring and Prediction	tional Waterway. W91-11039 6E
Stimulation of the Reductive Dechlorination of	by Mathematical Modelling: North Sea and Ad-	
Tetrachloroethene in Anaerobic Aquifer Micro- cosms by the Addition of Toluene.	jacent Estuaries.	MOROCCO
W91-11344 5B	W91-10600 5B	Dynamics of Non-01 Vibrio cholerae in Experi- mental Sewage Stabilization Ponds Under Arid
Soil Moisture: Empirical Data and Model Re-	Clostridium perfringens, as an Indicator Micro-	Mediterranean Climate.
sults.	organism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems.	W91-10690 5D
W91-11413 2G	W91-10686 Treatment Systems.	Aeromonas Species Stabilization Ponds in the
Four-Parameter Model for the Estimation of		Arid Region of Marrakesh, Morocco, and Rela-
Rainfall Frequency in South-West England. W91-11415 2B	Status of Ground Water in the 1100 Area. W91-10732 5B	tion to Fecal-Pollution and Climatic Factors. W91-10842 5D
	10/02	10012

MOST PROBABLE NUMBER TEST Most Probable Number Method for the Enumeration of Legionella Bacteria in Water. W91-10640 5A	MYCOBACTERIUM Growth and Inactivation Kinetics of Mycobacteria Biofilms. W91-10642 5B	Hydrogeologic Inferences from Drillers' Logs and from Gravity and Resistivity Surveys in the Amargosa Desert, Southern Nevada. W91-10996 5E
MOUNTAIN LAKES	NANCY CREEK	
Potential Effects of Global Warming on the Primary Productivity of a Subalpine Lake. W91-10819 2H	Update of Flood-Flow Characteristics of Nancy Creek at Georgia Highway 400 Extension Near Atlanta, Georgia.	Evolution of Nevada's Water Laws, as Related to the Development and Evaluation of the State's Water Resources, from 1866 to about 1960.
MOUNTAIN STREAMS	W91-10762 2E	W91-11573 6E
Comparison of Nocturnal Drainage Flow in	NAPROPAMIDE	
Three Tributaries. W91-10501 2E	Aqueous Photolysis of Napropamide. W91-11376 5B	NEW ENGLAND What Makes Regional Organizations Succeed or
MOUNTAINS	NARCOSIS	Fail.
Microclimatological Investigations in the Tropi- cal Alpine Scrub of Maui, Hawaii: Evidence for	Acute Aquatic Toxicity of Alkyl Phenol Ethox- ylates.	W91-11005 6A NEW JERSEY
a Drought-Induced Alpine Timberline.	W91-10833 5C	Superfund Record of Decision: Kin-Buc Land-
W91-10878 2I	NARRAGANSETT BAY	fill, NJ.
MUD	Measurement of the Different Forms of Zinc in	W91-10755 5G
Fluidization of Marine Mud by Waves. W91-10533 5B	Narragansett Bay Water Based on the Rate of	Development and Implementation of a Remedial
W91-10533 5B	Uptake by a Chelating Resin. W91-10926 2K	Investigation Work Plan and Data Management
MUD FLATS	W 91-10920	System.
Annual Bacterial Production in Relation to	NATIONAL PARKS	W91-10799 5G
Benthic Microalgal Production and Sediment Oxygen Uptake in an intertidal Sandflat and an	Characterization of Radioactivity in Hot Springs	Managing Transboundary Water Diversions:
Intertidal Mudflat.	National Park, Arkansas. W91-10846 2K	Experience From a Private Utility.
W91-10865 2L		W91-11045 6A
Behavior of Heavy Metals in a Mud Flat of the	NATIONAL WATER DATA EXCHANGE	
Scheldt Estuary, Belgium.	Directory of Member Organizations of the Na- tional Water Data Exchange (NAWDEX).	Geophysical and Chemical Investigations of Ground Water at Five Industrial or Waste-Dis-
W91-10872 5B	W91-11574 10D	posal Sites in Logan Township, Gloucester
MUDFLOWS	Disserting of Assistance Control of the Matienal	County, New Jersey, 1983-87.
Snow and Ice Perturbation during Historical	Directory of Assistance Centers of the National Water Data Exchange (NAWDEX).	W91-11092 5B
Volcanic Eruptions and the Formation of	W91-11575 10D	
Lahars and Floods. W91-11394 2C	NUMBER OF STREET	Major Incident of Dioxin Contamination: Sedi- ments of New Jersey Estuaries.
W91-11394 2C	NEBRASKA Central Platte Natural Resources District's	W91-11341 5B
MUNICIPAL WASTES	Groundwater Management Program.	
Mariculture and Eutrophication in Jinhae Bay, Korea.	W91-11190 5G	NEW MEXICO
W91-10558 5B	NECKAR RIVER	Superfund Record of Decision: South Valley (PL-83), NM.
	Species and Genera of Enterobacteriaceae in	W91-10721 5G
Development of Risk Assessment Methodology for Land Application and Distribution and Mar-	River Neckar and After River Bank Filtration	
keting of Municipal Sludge.	and Their Resistance Patterns to Antibiotics and Heavy Metal Salts.	Geohydrology and Simulation of Ground-Water
W91-10708 5E	W91-10675 5B	Flow in the Mesilla Basin, Dona Ana County, New Mexico, and El Paso County, Texas.
Waste Disposal Facilities and Community Re-		W91-11088 2F
sponse: Tracing Pathways from Facility Impacts	NEEM Influence of Leaf Leachate-Enriched Water of	
to Community Attitude.	Neem (Azadirachta indica A. Juss.) and Shirish	Hydrogeology of the Point Lookout Sandstone
W91-11280 5E	(Albizzia lebbek Benth.) on the Growth of Eich-	in the San Juan Structural Basin, New Mexico, Colorado, Arizona, and Utah.
MUNICIPAL WASTEWATER	hornia crassipes (Mart.) Solms. W91-11449 2I	W91-11114 2F
Boston's Sewage Outfall. W91-10485 5D	W91-11449 2I	
W91-10485 5D	NEGOTIATIONS	NEW YORK
Mathematical Simulation of Pollutant Disper-	Negotiation Techniques to Resolve Western Water Disputes.	Iterative Evaluation of a Lake Water Quality Management Program.
sion. W91-10488 5B	W91-10817 6E	W91-10808 5G
Managing Toxic Substances in Municipal	NETWORK DESIGN Utility of Multiple-Completion Monitoring	Availability of Ground Water from Unconsoli-
Wastewater Treatment Plants. W91-11540 5D	Wells for Describing a Solvent Plume.	dated Deposits in the Mohawk River Basin, New York.
	W91-10800 7A	W91-11104 2F
MUNICIPAL WATER	Knowledge-Based Systems and Operational Hy-	
Municipal Ground Water from Ancient Crystal- line Bedrock.	drology.	Hydrogeology of the Valley-Fill Aquifer at
W91-10822 2F	W91-11273 7C	Owego, Tioga County, New York. W91-11105 2F
MURRAY-DARLING RIVER BASIN	Hydrometric Data Collection and Interpretation	W91-11105 2F
Salinity and Evaporation in the River Murray Basin, Australia.	in the Prairie Provinces and Northwest Territo- ries.	Funding New York State's Integrated Pest Man- agement Program.
W91-10989 2E	W91-11278 7A	W91-11180 6C
	NEUTRALIZATION	Home Water Treatment: Remediating Aldicarb
MUSSELS  Comparison of Two Methods for the Recovery	Design of Economic and Efficient Treatment	Contamination in Suffolk County, New York.
of Rotavirus from Mussels and Oysters.	Station for Acidic Streams.	W91-11189 5F
W91-10697 5A	W91-11077 5G	
Assessment of Mercury Toxicity by the Changes	NEVADA	NEW YORK CITY New York City's Delaware River Basin
in Oxygen Consumption and Ion Levels in the Freshwater Snail, Pila globosa, and the Mussel,	Phosphorus in the Truckee River Between Vista and Patrick, Storey and Washoe Counties,	Supply-A Case Study in Interstate Coopera-
Lamellidens marginalis.	Nevada, August 1984.	tion W91-11046 6E
W91-11304 5C	W91-10763 5A	W91-11046 6E

### **NEW ZEALAND**

NEW ZEALAND Development of Environmental Control Legis- lation and Effluent Standards for Australasian Wood Processing Industries.	Simultaneous Ultraviolet Spectrophotometric Determination of Nitrate and Nitrite in Water. W91-10824 5A	Non-Point Source Loadings of Nutrients and Dissolved Organic Carbon from an Agricultural- Suburban Watershed in East Central Florida. W91-10927 5B
W91-11472 5G	Aerobic and Anaerobic Biofiltration in an Aqua- culture Unit-Nitrite Accumulation as a Result	Riparian Zone as a Source of Phosphorus for a
Treatability of Bleached Kraft Pulp and Paper Mill Wastewaters In a New Zealand Aerated	of Nitrification and Denitrification. W91-11547 5D	Groundwater-Dominated Lake. W91-10931 2H
Lagoon Treatment System. W91-11499 5D	NITROGEN	Seasonal Changes in the Sanitary Bacterial Qual-
	Runoff Characteristics of COD, BOD, C, N, and	ity of Water Draining a Small Upland Catch-
NIAGARA FALLS Watershed Years at Niagara Falls: Canadian and	P Loadings from Rivers to Enclosed Coastal Seas.	ment in the Yorkshire Dales. W91-10935 5B
American Policy Responses to New Meanings of Power, 1905-1914.	W91-10521 5B	
W91-11038 6E	Seasonal Changes of Organic Carbon and Nitro- gen Production by Phytoplankton in the Estuary	Economic Assessment of the Water Quality Benefits of Conservation Tillage on Southwestern
NICKEL Heavy Metal Distribution in the Godvari River	of River Tamagawa.	Ontario Cropland. W91-11050 3F
Basin.	W91-10604 5B	Techniques for Estimation of Storm-Runoff
W91-11445 5B	Studies for a Simultaneous Use of Liquid	Loads, Volumes, and Selected Constituent Con-
NIGER RIVER BASIN Hydrobiological Survey of the Chancrai Creek	Manure and Sewage Sludge. W91-11157 5E	centrations in Urban Watersheds in the United States.
System, Lower Niger Delta, Nigeria.	Slurry and Sludge Spreading Methods.	W91-11094 5B
W91-11524 5C	W91-11161 5E	Nonpoint Sources: Agenda for the Future.
NIGERIA	Deforestation and Leaching of Nitrogen as Ni-	W91-11098 6E
Tar Balls on Ibeno-Okposo Beach of South-East Nigeria.	trates into Underground Water in Intertropical	Agrichemicals and Groundwater Protection:
W91-10876 5B	Zones: The Example of Cote d'Ivoire. W91-11446 2F	Resources and Strategies for State and Local Management.
Aquifers in the Benin Formation (Miocene- Recent), Eastern Niger Delta, Nigeria: Lithos-	Criteria for Nutrient-Balanced Operation of Ac-	W91-11162 5G
tratigraphy, Hydraulics, and Water Quality. W91-11443 2F	tivated Sludge Process. W91-11493 5D	Agrichemicals and Ground Water: Assumptions
NITRATES	Nitrogen and Phosphorus Limits for Nutrient	about Farmer Information Processes. W91-11163 6B
Increased Precipitation Acidity in the Central	Deficient Industrial Wastewaters.	Communicating with Farmers: Providing Useful
Sierra Nevada. W91-10471 5B	W91-11494 5D	and Reliable Sources of Information.
	Nitrogen Dynamics of Pulp and Paper Sludge Amendment to Forest Soils.	W91-11164 5G
Statistical Analysis of Errors in Estimating Wet Deposition Using Five Surface Estimation Algo-	W91-11510 5E	Emerging Issues at the Intersection of Agricul- tural and Environmental Policy.
rithms. W91-10474 7B	NITROGEN COMPOUNDS	W91-11165 5G
	Factors Affecting the Relationship Between the	Overview of U.S. Geological Survey Water-
Simultaneous Ultraviolet Spectrophotometric Determination of Nitrate and Nitrite in Water. W91-10824 5A	NBOD Values and the Amounts of Nitrogenous Pollutants: A Field Study on the Lee River. W91-10940 5C	Resources Information Programs. W91-11166 10D
	· ·	Minnesota District, Water Resources Division:
Fate of Acetone in an Outdoor Model Stream with a Nitrate Supplement, Southern Mississippi, U.S.A.	Quantitative Determination of Acrylonitrile in an Industrial Effluent by Ambient-Temperature Purge and Trap Capillary GC-MS and by	Information and Technical Assistance. W91-11167 2F
W91-10903 5B	Heated Purge and Trap GC-FID.	
Nitrate Removal by Denitrification in Alluvial	W91-11336 5A	Planned Studies of Agrichemicals in Ground and Surface Water in the Mid-Continental
Ground Water: Role of a Former Channel. W91-10909 5B	NITROGEN OXIDES	United States.
	Impact of Changing Regional Emissions on Pre- cipitation Chemistry in the Eastern United	W91-11168 5B
Leaching of Ammonium Nitrate under Field Conditions: Studies on Kinetics of Nitrification	States.	National Program for Soil and Water Conserva- tion. Its Effect on USDA Services.
and Nitrate Reduction in an Ultisol Profile.	W91-10473 5G	W91-11169 3F
W91-10999 5B	NITROGEN REMOVAL	Soil Conservation Service and Extension: Coop-
Central Platte Natural Resources District's	Design of Sewage-Treatment Plants in Brisbane, Australia.	erating to Enhance Services (MES Portion).
Groundwater Management Program. W91-11190 5G	W91-11361 5D	W91-11170 6E
Deforestation and Leaching of Nitrogen as Ni-	NONIONIC SURFACTANTS	Coordinating Roles and Services: Soil Conserva-
trates into Underground Water in Intertropical Zones: The Example of Cote d'Ivoire.	Accumulation of Refractory 4-Nonylphenol During Mesophilic Anaerobic Sludge Stabiliza-	tion Service and Extension Service. W91-11171 6E
W91-11446 2F	tion. W91-10707 5D	Wellhead Protection-Information and Re-
NITRIFICATION		sources.
Influence of Reactor Mixing Characteristics on the Rate of Nitrification in the Activated Sludge	NONPOINT POLLUTION SOURCES  Permitting Nonpoint Sources: Programs, Provi-	W91-11172 5G
Process. W91-10932 5D	sions, Problems and Potential. W91-10730 5G	Pesticides and Drinking Water Information: A Perspective from EPA's National Pesticide
Leaching of Ammonium Nitrate under Field	Effects of Land-Use Buffer Size on Spearman's	Survey. W91-11173 5D
Conditions: Studies on Kinetics of Nitrification	Partial Correlations of Land Use and Shallow	
and Nitrate Reduction in an Ultisol Profile. W91-10999 5B	Ground-Water Quality. W91-10761 4C	Soil Survey Information System: A User Friend- ly Soil Information System.
NITRITES	Studies on the Environmental Persistence of S-	W91-11174 7C
Spectrophotometric Determination of Nitrite in	31183 (Pyriproxyfen): Adsorption onto Organic	ATLAS*GRAPHICS: An Affordable Mapping
Polluted Waters Using 3-Nitroaniline. W91-10823 5A	Matter and Potential for Leaching through Soil. W91-10831 5B	System.
1771-10023 JA	W >1-10031 3B	W91-11175 7C

National Pesticide Usage Data Base. W91-11176 7C	Maryland's Train-The-Trainer Program House- hold Hazardous Waste.	System of the German Aerospace Research Es- tablishment.
	W91-11200 5G	W91-10742 5B
Crop Data Management Systems, Inc. Meeting California's Pesticide Regulation Challenge. W91-11177 5G	Farm Bureau's Groundwater and Environmental	NORTHERN IRELAND
	Quality Self-Help Checklist for Farmsteads and Farm Fields.	Variation in the Acidity of Ground and Surface Waters in Northern Ireland.
Application of the DRASTIC Mapping System for Evaluating Ground Water Pollution Poten-	W91-11201 5G	W91-11407 2H
tial in Ohio. W91-11178 5B	Florida's Pesticide Water Quality Education	NOVA SCOTIA
	Program. W91-11202 5G	Effect of a Spring Phytoplankton Bloom on
Funding Groundwater Protection Programs: Iowa's Groundwater Protection Fund.		Dissolved Copper Speciation in Bedford Basin. W91-10543 5B
W91-11179 5G	Farmer-Initiated Project to Promote Sustainable Agriculture in Cooperation with the Extension	Coulometric Measurement of Primary Produc-
Funding New York State's Integrated Pest Man-	Service.	tion, with Comparison against Dissolved
agement Program.	W91-11203 3F	Oxygen and 14-C Methods in a Seasonal Study.
W91-11180 6C	Strategies for Nonprofit Organizations for Pre-	W91-10868 2L
Minnesota Clean Water Partnership Program.	venting Agrichemical Contamination of Ground Water.	Use of the Intertidal Zone by Fish in Nova
W91-11181 5G	W91-11204 5G	Scotia.
Wellhead Protection in Massachusetts: Protect-	In the Land of the Giants: Grassroots Organiz-	W91-11557 2L
ing Public Water Supplies from Pesticide Impacts.	ing in California's Central Valley.	NUCLEAR ACCIDENTS
W91-11182 5G	W91-11205 5G	Evidence of Chernobyl Fallout on a Temperate
Wisconsin's Risk Assessment Based Numerical	Simazine Concentrations in a Stream Draining	Himalayan Glacier. W91-10950 5B
Groundwater Standards Program.	an Agricultural Catchment.	
W91-11183 5G	W91-11364 4C	NUCLEAR WASTES
Red River Basin Grass Roots Policy Process.	NONPOINT SOURCE POLLUTION	Synthesis and Decomposition of Novel Organo- phosphorus Complexants.
W91-11185 6B	Micro-Targeting Cropland Retirement for	W91-11372 5D
Innovative Subsurface Sewage Management: A	Water Quality Improvement: Measuring the Benefits of Increased Information.	NUCLEATION
Program to Protect Idaho's Rathdrum Prairie	W91-11052 3F	Aerosol and Hydrometeor Concentrations and
Aquifer. W91-11186 5G	Rural Clean Water Program.	Their Chemical Composition During Winter
	W91-11184 5G	Precipitation Along a Mountain Slope: III. Size- Differentiated In-Cloud Scavenging Efficiencies.
Minnesota's Olmsted County: A Cooperative Health Based Perspective on Zoning and Plan-	NOREPINEPHRINE	W91-11253 2B
ning.	Decreased Norepinephrine and Epinephrine	
W91-11187 6B	Contents in Chromaffin Tissue of Rainbow	NUCLEIC ACIDS
Northwest Kansas Groundwater Management	Trout (Oncorhynchus mykiss) Exposed to	Direct Detection of Enteropathogenic Bacteria in Estuarine Water Using Nucleic Acid Probes.
District No. 4. An Abandoned Well Program. W91-11188 5G	Diethyldithiocarbamate and Amylxanthate. W91-10901 5C	W91-10664 5A
	NORTH AMERICA	Detection of Hepatitis A Virus and Other Enter-
Home Water Treatment: Remediating Aldicarb Contamination in Suffolk County, New York.	Water Supply Implication of Climate Change in	oviruses in Wastewater and Surface Water Sam-
W91-11189 5F	Western North American Basins.	ples by Gene Probe Assay.
Control Blotte Natural Bassansas Districtle	W91-11059 2B	W91-10665 5A
Central Platte Natural Resources District's Groundwater Management Program.	Variability of Glacier Mass Balances in Western	Detection of Poliovirus in Water by Direct Isc-
W91-11190 5G	North America.	lation of the RNA and Hybridization with Gene Probes.
Returnable Pesticide Containers: Maine's Depos-	W91-11391 2C	W91-10666 5A
it and Collection System.	NORTH CAROLINA	
W91-11191 5G	Superfund Record of Decision: Chemtronics	Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water.
Oregon Pesticide Container Initiative.	(Amendment), NC. W91-10713 5G	W91-10667 3A
W91-11192 5E		
Minnesota Waste Pesticide Collection Pilot	Superfund Record of Decision: Celanese Fibers Operations, NC.	Detection of Rotaviruses in Water by Gene Probes.
Project.	W91-10759 5G	W91-10668 5A
W91-11193 5E	Evaluation of Site-Selection Criteria, Well	Growth of Clinical Indiana of Astronisms in a
Urban Pesticide Waste Management: Strategies	Design, Monitoring Techniques, and Cost Anal-	Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA.
for Education and Collection. W91-11194 5E	ysis for a Ground-Water Supply in Piedmont	W91-10669 5A
	Crystalline Rocks, North Carolina. W91-11596 2F	PCR and Environmental Monitoring: The Way
Pesticide Rinseate Management Plan. W91-11195 5G		Forward.
	NORTH SEA North Sea Strategies.	W91-10670 5A
AgriSource: The Information System for Crop Technology.	W91-10530 5G	Comparative Study on Adsorption Mechanisms
W91-11196 10D	5-Year Scientific Research Programme for Man-	of RNA-F-Specific Coliphages and Poliovirus in
Soil Tec: A Computerized Soil-Specific Fertiliz-	5-Year Scientific Research Programme for Managing Coastal Seas.	Activated Studge Process.
er Application System.	W91-10531 2L	W91-10694 5D
W91-11197 7C	Pollutant Transport Monitoring and Prediction	NUMERICAL ANALYSIS
Professionalism in Agriculture: Seeking a Train-	by Mathematical Modelling: North Sea and Ad-	Numerical Modelling of Vertical Ground Move
ing Standard.	jacent Estuaries.	ments in Expansive Soils. W91-10945 2G
W91-11198 5G	W91-10600 5B	
Developing a Groundwater Training Program	ARCHIMEDES IIa Experiment on Oil Slick	Similarity Solutions of the Shallow Water Equa- tions.
for Pesticide Users. W91-11199 5G	Detection over the North Sea-April 1988- Measurement Results Obtained by the E-SAR	W91-10987 8E

# **NUTRIENT CONCENTRATIONS**

NUTRIENT CONCENTRATIONS	OCEAN CIRCULATION	Inhibition of NO3(-), NH4(+), and PO4(3-)
Runoff Characteristics of COD, BOD, C, N, and	Investigation on Turbidity and Flow Patterns in	Uptake in Anabaena doliolum Exposed to a Pe-
P Loadings from Rivers to Enclosed Coastal	Half-Closed Sea Area.	troleum Oil.
Seas.	W91-10532 5B	W91-10825 5C
W91-10521 5B	***************************************	
	Brine-Induced Advection of Dissolved Aromat-	Immunochemical Detection of Cytochrome
Present State of Environmental Pollution in	ic Hydrocarbons to Arctic Bottom Waters.	P450IA1 Induction in Cod Larvae and Juveniles
Coastal Sea Area and Measures for Protection.	W91-11340 5B	Exposed to a Water Soluble Fraction of North
W91-10540 5B		Sea Crude Oil.
Innert of Nations Engishment and Their Role	OCEAN DUMPING	W91-10871 5A
Impact of Nutrient Enrichment and Their Rela-	Application of a Hazard Assessment Research	
tion to the Algal Bloom in the Adriatic Sea.	Strategy to the Ocean Disposal of a Dredged	Tar Balls on Ibeno-Okposo Beach of South-East
W91-10544 5C	Material: Overview.	Nigeria.
Eastern Mediterranean: A Marine Desert.	W91-10740 5E	W91-10876 5B
W91-10553 2H		
	Hazard Assessment Research Strategy for	Oil Transport Management and Marine Pollu-
NUTRIENT REQUIREMENTS	Ocean Disposal.	tion Control: Oil Spill Prevention.
Trickle Irrigation of Sunflower With Municipal	W91-11551 5E	W91-11081 5G
Wastewater.		
W91-11435 3F	OCEANOGRAPHY	Brine-Induced Advection of Dissolved Aromat-
	Meteorology and Oceanography in the Seto	ic Hydrocarbons to Arctic Bottom Waters.
NUTRIENT TRANSPORT	Inland Sea.	W91-11340 5B
Water Exchange and Transport of Matter in the	W91-10520 2L	
Seto Inland Sea.		Remediation of Floating, Open Water Oil Spills:
W91-10527 2L	5-Year Scientific Research Programme for Man-	Comparative Efficacy of Commercially Avail-
	aging Coastal Seas.	able Polypropylene Sorbent Booms.
Scavenging Processes of Marine Particles in	W91-10531 2L	W91-11447 5G
Osaka Bay.		
W91-10538 5B	ODOR CONTROL	OIL RESERVOIRS
Parket and the second of the s	Waste Stabilization Ponds in Grand Cayman,	NOAA Satellite Data in Natural Oil Slick De-
Estimation of Phosphorus Exchange Between	Cayman Islands.	tection, Otway Basin, Southern Australia.
Littoral and Pelagic Zones During Nighttime	W91-10691 5D	W91-11296 5A
Convective Circulation.		
W91-10863 2H	Odour Problems with Sewage Sludge.	OIL SHALE
m: : m	W91-11121 5D	Determination of Selenium Species in Spent Oil
Riparian Zone as a Source of Phosphorus for a		Shale Leachates by Ion Chromatography.
Groundwater-Dominated Lake.	ODORS	W91-11553 5B
W91-10931 2H	Odour Problems with Sewage Sludge.	
Factors Affaction the Balationship Batuman the	W91-11121 5D	OIL SKIMMERS
Factors Affecting the Relationship Between the		Remediation of Floating, Open Water Oil Spills:
NBOD Values and the Amounts of Nitrogenous	New Standards for the Determination of Geos-	Comparative Efficacy of Commercially Avail-
Pollutants: A Field Study on the Lee River.	min and Methylisoborneol in Water by Gas	able Polypropylene Sorbent Booms.
W91-10940 5C	Chromatography/Mass Spectroscopy.	W91-11447 5G
NUTRIENTS	W91-11329 5A	W71-11447 3G
	W)1-11325	OIL SLICKS
Macroalgal-Sediment Nutrient Interactions and	OFF-RIVER STORAGE	Oil Spill Risk Simulation Model.
Their Importance to Macroalgal Nutrition in a	Off-River Storages as Sources and Sinks for	W91-11001 5B
Eutrophic Estuary.	Environmental Contaminants.	W31-11001 3B
W91-10497 2L	W91-10851 5B	NOAA Satellite Data in Natural Oil Slick De-
Comparison of Nutritional Environment of	W91-10831 3B	tection, Otway Basin, Southern Australia.
Closed Coastal Seas in Western Kyushu.	OFFSHORE PLATFORMS	
W91-10595 2L	Tar Balls on Ibeno-Okposo Beach of South-East	W91-11296 5A
W 91-10393	Nigeria.	OIL SPILLS
Effect of Dissolved Nutrients and Inorganic Sus-	W91-10876 5B	Oil Spills in Mangroves: A Conceptual Model
pended Solids on the Survival of E. coli in	W91-106/6 3B	Based on Long-term Field Observations.
Seawater.	ОНІО	
W91-10638 5B	Application of the DRASTIC Mapping System	W91-10489 5B
1171 10000		New Dead Sea.
Inhibition of NO3(-), NH4(+), and PO4(3-)	for Evaluating Ground Water Pollution Poten- tial in Ohio.	W91-10504 5C
Uptake in Anabaena doliolum Exposed to a Pe-		W 71-10304 SC
troleum Oil.	W91-11178 5B	Effects of Oil Pollution on Bio-Ecology and
W91-10825 5C	OIL	Fisheries on Certain Enclosed Coastal Regions
		of Arabian Sea.
Trace Metal Interactions with Marine Phyto-	Aqueous Surfactant Washing of Residual Oil	
plankton.	Contamination from Sandy Soil.	W91-10555 5B
W91-10853 2L	W91-10796 5G	Fact Acies Sees Hymothetical Oil Smill Tenies
	OH BOTTIMON	East Asian Seas: Hypothetical Oil Spill Trajec-
Proximate Composition and Nutrient Elements	OIL POLLUTION	tories.
in the Unusual Algal Jellies of Lake Oguta in	New Dead Sea.	W91-10608 5E
Southern Nigeria.	W91-10504 5C	Using Oil Spill Dispersants on the Sea.
W91-11408 2H	78 . 401 PH	
	Effects of Oil Pollution on Bio-Ecology and	W91-10716 5G
Influence of Flooded Soil on Chemical Compo-	Fisheries on Certain Enclosed Coastal Regions	Biotechnology Degradation and Mitigation of
sition of Annual Ryegrass and Digestibility by	of Arabian Sea.	Offshore Oil Spills, Phase 1. Main Report: Tech-
Meadow Voles.	W91-10555 5B	nology to Enhance Biodegradation of Oil Spills
W91-11536 2I	Main on som pro-	State of the Art and Perspectives for Technolo
Markey V - N - Out At A	Using Oil Spill Dispersants on the Sea.	
Nutrient Loading Status of the Conestoga River	W91-10716 5G	gy Development.
Basin, 1985-1989.	Manharinia Production of Militarian of Train	W91-10735 5G
W91-11599 5G	Mechanistic Evaluation of Mitigation of Petrole-	ADCUMEDES He Experiment on Oil Clint
Assessment of April 1991 Markey D. L.	um Hydrocarbon Contamination by Soil	ARCHIMEDES IIa Experiment on Oil Slick
Assessment of Agricultural Nutrient Point	Medium.	Detection over the North Sea-April 1988-
Source Discharge from Tile Drains, Spring and	W91-10779 5G	Measurement Results Obtained by the E-SAR
Overland Runoff from Two Farms, Dauphin	Paradallia of Calle and Committee Co.	System of the German Aerospace Research Es
County, Pennsylvania.	Permeability of Soils with Organic Fluids.	tablishment.
W91-11600 5B	W91-10783 5B	W91-10742 5E

5B

Tar Balls on Ibeno-Okposo Beach of South-East	Statistical Characterization of Atrazine Residues	Organic Carbon Accumulation in Baffin Bay
Nigeria. W91-10876 5B	in Southwestern Ontario Great Lakes Tributaries.	and Paleoenvironment in High Northern Lati- tudes During the Past 20 m. y.
010 110:10: 1: 14:11	W91-11064 5B	W91-10791 2J
Oil Spill Risk Simulation Model. W91-11001 5B	OPEN-CHANNEL FLOW	ORCANIC COMPOUNDS
W91-11001 5B	Open Channel Velocity Profiles over a Zone of	ORGANIC COMPOUNDS  Permeability of Soils with Organic Fluids.
Environmental Problems and Solutions: Green-	Rapid Infiltration.	W91-10783 5B
house Effect, Acid Rain, Pollution.	W91-10984 8B	W31-10/63
W91-11066 5B	Cimilarity Cabutians of the Challery Water Baye	Method for Assessing Residual NAPL Based on
	Similarity Solutions of the Shallow Water Equa- tions.	Organic Chemical Concentrations in Soil Sam-
Oil Transport Management and Marine Pollu- tion Control: Oil Spill Prevention.	W91-10987 8B	ples.
W91-11081 5G		W91-10797 5A
W31-11001	Computation of Uniform Flow in Open Chan-	Biodegradation of Chemicals at Trace Concen-
Brine-Induced Advection of Dissolved Aromat-	nels with Flood Plains. W91-11281 2E	trations.
ic Hydrocarbons to Arctic Bottom Waters.	W91-11281 2E	W91-11102 5B
W91-11340 5B	Correction Coefficients for Uniform Channel	
Remediation of Floating, Open Water Oil Spills:	Flow.	Theoretical Study of the Significance of None-
Comparative Efficacy of Commercially Avail-	W91-11282 2E	quilibrium Dissolution of Nonaqueous Phase
able Polypropylene Sorbent Booms.	Roughness Coefficients of Watercourse Revet-	Liquids in Subsurface Systems. W91-11228 5B
W91-11447 5G	ted With Half-Circular Concrete Pipes. Results	W91-11228 . 3B
	of Field Measurements in Watercourse S 333 at	Use of 2,2-Dimethoxypropane for the Direct
Hydrobiological Survey of the Chanomi Creek	Maarkedal.	Gas Chromatographic-Mass Spectrometric De-
System, Lower Niger Delta, Nigeria. W91-11524 5C	W91-11431 8B	termination of Some Organic Compounds in
W91-11524 5C	OPERATIONAL HYDROLOGY	Water.
OKAVANGO DELTA	Knowledge-Based Systems and Operational Hy-	W91-11245 5A
Visual Interpretation of a Landsat Mosaic of the	drology.	Methyl and Butyltin Compounds in Water and
Okavango Delta and Surrounding Area.	W91-11273 7C	Sediments of the Rhine River.
W91-10879 2H	OPTICAL PROPERTIES	W91-11335 5B
OKLAHOMA	Optics of Little Sodus Bay.	
Electrical and Kinematic Structure of the Strati-	W91-10980 2H	ORGANIC LOADING
form Precipitation Region Trailing an Oklahoma		Water Exchange and Transport of Matter in the
Squall Line.	ORCHIDS	Seto Inland Sea.
W91-10514 2B	Effects of Acid Rain on Epiphytic Orchid Growth.	W91-10527 2L
	W91-11076 5C	Non-Point Source Loadings of Nutrients and
Hydrology of the Arbuckle Mountains Area,	w31-110/0	Dissolved Organic Carbon from an Agricultural-
South-Central Oklahoma. W91-11590 2F	OREGON	Suburban Watershed in East Central Florida.
W91-11390 2F	Managing Oregon's Estuarine Resources Lands.	W91-10927 5B
OLIGOTROPHIC LAKES	W91-10508 2L	Design of Courses Treetment Dients in Brichana
Longitudinal Development of Macroinverte-	Confirmatory Chemical Analyses and Solid	Design of Sewage-Treatment Plants in Brisbane, Australia.
brate Communities Below Oligotrophic Lake	Phase Bioassays on Sediment from the Columbia	W91-11361 5D
Outlets.	River Estuary at Tongue Point, Oregon.	
W91-10856 2H	W91-10753 5B	ORGANIC MATTER
OLIGOTROPHY	Pacific Salmon at the Crossroads: Stocks at Risk	Remobilization of Cu from Marine Particulate
Eastern Mediterranean: A Marine Desert.	from California, Oregon, Idaho, and Washing-	Organic Matter and from Sewage.
W91-10553 2H	ton.	W91-10923 5E
	W91-10834 8I	Sulfur Enrichment of Humic Substances in
OMURA BAY	Oregon Pesticide Container Initiative.	Delaware Salt Marsh Sediment Core.
Formation of Oxygen-Deficient Water Mass in	W91-11192 5E	W91-11258 2I
Omura Bay. W91-10592 5B		
W 91-10392 3B	Geologic Framework of the Columbia Plateau	Reactive Continuum Representation of Organi
ONTARIO	Aquifer System, Washington, Oregon, and	Matter Diagenesis. W91-11448 2
Analysis of Three-Dimensional Ground Move-	Idaho. W91-11571 2F	W91-11440
ments: The Thunder Bay Tunnel.	W/P113/1	ORGANIC PESTICIDES
W91-10775 8A	ORGANIC ACIDS	Use of 2,2-Dimethoxypropane for the Direct
Depth of Fractures and Active Ground-Water	Synthesis and Decomposition of Novel Organo-	Gas Chromatographic-Mass Spectrometric De
Flow in a Clayey Till Plain in Southwestern	phosphorus Compiexants.	termination of Some Organic Compounds is
Ontario.	W91-11372 5D	Water.
W91-10959 2F	ORGANIC CARBON	W91-11245 5/
Socio-Economic Considerations in Remedial	First-Order Organic Carbon Budget in the St	ORGANIC POLLUTANTS
Action Planning for the Great LakesA Case	Lawrence Lower Estuary from 15C Data.	Occurrence of Appendix IX Organic Constitu
Study for Sustainable Development.	W91-10498 2L	ents in Disposal Site Ground Water.
W91-11031 6A	Runoff Characteristics of COD, BOD, C, N, and	W91-10801 51
	P Loadings from Rivers to Enclosed Coastal	Fate and Effects of Semivolatile Organic Pollu-
Industrial Water Pricing for Ontario: Towards	Seas.	ants During Anaerobic Digestion of Sludge.
Realistic Pricing.	W91-10521 5B	W91-10884 51
W91-11048 6C	Seasonal Changes of Organic Carbon and Nitro-	
Economic Assessment of the Water Quality Ben-	gen Production by Phytoplankton in the Estuary	Bioavailability of Organic Pollutants in Bores
efits of Conservation Tillage on Southwestern		Waters with Varying Levels of Dissolved O
Ontario Cropland.	W91-10604 5B	ganic Material.
W91-11050 3F		W91-10936 5
Social and Private Returns from Wetland Pres-	Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Poten-	
ervation.	tial Regrowth of Bacteria.	cals from Sewage to Agricultural Soil.
W91-11057 5G	-	W91-11123 5

5B

### **ORGANIC POLLUTANTS**

Groundwater Contamination By Anthropogenic Organic Compounds From Waste Disposal Sites: Transformations and Behavior.	Phenyltins in Water, Sediment, and Biota of Freshwater Marinas. W91-11342 5B	OYSTERS  Comparison of Two Methods for the Recovery of Rotavirus from Mussels and Oysters.
W91-11378 5B		W91-10697 5A
Studies on the Effects of Some Organic Pollut- ants on the Heavy Metal Transport in an Indian Soil.	OROGRAPHIC PRECIPITATION Three-Dimensional Simulation of Airflow and Orographic Rain Over the Island of Hawaii. W91-10517 2B	OZARK NATIONAL SCENIC RIVERWAYS  Delineation of Flooding within the Ozark Na- tional Scenic Riverways in Southeastern Missou-
W91-11457 5C	Effect of Decoupled Low-Level Flow on	ri-Akers and Alley Spring.
ORGANIC SOLVENTS	Winter Orographic Clouds and Precipitation in	W91-11578 2E
Stimulation of the Reductive Dechlorination of Tetrachloroethene in Anaerobic Aquifer Micro- cosms by the Addition of Toluene.	the Yampa River Valley. W91-11410 2B	Delineation of Flooding within the Ozark Na- tional Scenic Riverways in Southeastern Missou-
W91-11344 5B	OSAKA BAY	riRound Spring and Powder Mill. W91-11579 2E
	Scavenging Processes of Marine Particles in Osaka Bay.	
ORGANIC WASTES Processing Organic Waste Products to Black Soil and Organic Fertilizers.	W91-10538 5B Ecological Modelling at Osaka Bay Related to	OZOFLOTATION  Efficiency of an Ozoflotation-Filtration Process for the Treatment of the River Thames at
W91-10705 5E	Long-Term Eutrophication.	Walton Works.
ORGANIZATIONS	W91-10556 5C	W91-11268 5F
Farmer-Initiated Project to Promote Sustainable	OSAKA PORT	OZONATION
Agriculture in Cooperation with the Extension Service. W91-11203 3F	Succession of Benthic Assemblages in Wild Bird Park, a Sanctuary Established on Reclaimed	Efficiency of an Ozoflotation-Filtration Process for the Treatment of the River Thames at
W91-11203	Land in Osaka Port. W91-10606 2L	Walton Works. W91-11268 5F
Strategies for Nonprofit Organizations for Pre-		
venting Agrichemical Contamination of Ground Water.	OUTFALL Environmental Assessment of Wastewater	Treatment of Pulp-Bleaching Effluents by Acti-
W91-11204 5G	Marine Disposal of Xiaogang Zone, Ningbo.	vated Sludge, Precipitation, Ozonation and Irra- diation.
In the Land of the Girete Germanta Commis	W91-10570 5E	W91-11491 5D
In the Land of the Giants: Grassroots Organiz- ing in California's Central Valley.	Assessment of the Environmental Capacity of	OZONE
W91-11205 5G	Enclosed Coastal Sea.	Ozone, Acidic Precipitation, and Soil Mg Ef-
ORGANOCHLORINE PESTICIDES	W91-10571 5E	fects on Growth and Nutrition of Loblolly Pine
Transport of the Fungicide Chlorothalonil from	Surface Dilution of Round Submerged Buoyant	Seedlings.
Its Operational Use on a Pond Ecosystem. W91-11299 5B	Jets. W91-10986 5E	W91-10918 5C PAINT INDUSTRY
Determination of Herbicide Residues in Soil in	Abbeystead Outfall Works: Background to Re-	Preliminary Data Summary for the Paint For-
the Presence of Persistent Organochlorine Insecticides.	pairs and Modifications and Lessons Learned. W91-11355 5D	mulating Point Source Category. W91-10714 5C
W91-11310 5A	OUTFALL SEWERS	PAKISTAN
Sheep-Dips as a Source of Pollution of Fresh- waters: A Study in Grampian Region.	Boston's Sewage Outfall. W91-10485 5D	Development of Small Hydro for Remote Areas of Northern Pakistan.
W91-11356 5B		W91-11215 8C
OBCANOLERER DROBERTIES	Marine Monitoring in Heterogeneous Environ- ments.	PALEOCLIMATOLOGY
ORGANOLEPTIC PROPERTIES  Development of an Enzyme-Linked Immunosor- bent Assay for Geosmin.	W91-11264 5A	Correlated Oceanic and Continental Records Demonstrate Past Climate and Hydrology of
W91-10921 5F	OVERLAND FLOW Streamflow Generation in a Headwater Basin on	North Africa (0-140 ka). W91-10788 2B
ORGANOPHOSPHORUS PESTICIDES Contamination of Ponds by Fenitrothion during	the Precambrian Shield. W91-11349 2E	Organic Carbon Accumulation in Baffin Bay
Forest Spraying.	OXIDATION	and Paleoenvironment in High Northern Lati-
W91-11298 5B	High-Performance Liquid Chromatographic	tudes During the Past 20 m. y. W91-10791 2J
ORGANOTIN COMPOUNDS	Study on Oxidation Products of Lignin and Humic Substances.	Manipulation of the Could Tentage of Wilder with
Bioaccumulation, Elimination and Metabolism of Triphenyltin Chloride by Early Life Stages of	W91-11513 5A	Variation of the Stable Isotopes of Water with Altitude in the Saint Elias Mountains of Canada. W91-11220 2C
Minnows Phoxinus phoxinus. W91-10877 5B	OXIDES  Adsorption of Viruses by Diatomaceous Earth	
	Coated with Metallic Oxides and Metallic Per-	PALEOHYDROLOGY Correlated Oceanic and Continental Records
Effects of Copper and Tributyltin on Stress Pro- tein Abundance in the Rotifer Brachionus plica- tilis.	oxides. W91-10659 5A	Demonstrate Past Climate and Hydrology of North Africa (0-140 ka).
W91-10900 5C	OXYGEN	W91-10788 2B
	Diel Oxygen Cycle in Three Subalpine Swiss	Evidence for Dilution of Deep, Confined
Organotin Stability During Storage of Marine Waters and Sediments. W91-11255 5A	Streams. W91-10899 2H	Ground Water by Vertical Recharge of Isotopi- cally Heavy Pleistocene Water.
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	OXYGEN DEFICIT	W91-10792 2F
Phenyltins in Water, Sediment, and Biota of Freshwater Marinas. W91-11342 5B	Bloom of Coscinodiscus wailesii and DO Deficit of Bottom Water in Seto Inland Sea.	Paleohydrologic Techniques Used to Define the Spatial Occurrence of Floods.
	W91-10549 5C	W91-11396 2E
ORGANOTINS	OXYGEN DEPLETION	PALEOLIMNOLOGY
Effect of Pesticide Treatments on Nontarget Or- ganisms in California Rice Paddies. W91-10835 5C	Formation of Oxygen-Deficient Water Mass in Omura Bay. W91-10592 5B	Geographical and Pollenanalytical Research of Lake Kleiner Barsch-See (Bez. Potsdam, GDR)
		(Geographische und Pollenanalytische Untersu-
Methyl and Butyltin Compounds in Water and Sediments of the Rhine River.	OXYGENATION Bubbleless Aeration.	chungen des Kleinen Barsch-Sees) (Bez. Pots- dam, DDR).
W91-11335 5B	W91-11222 5G	W91-11514 2H

History of Cladocera in the Kleiner Barsch-See, an Acidic, Calcium-Poor, Marshy Pond in the Middle European Flatland (Die Geschichte der	Efficiency With Which Drizzle and Precipitation Sized Drops Collide With Aerosol Particle W91-11252	s. ures of a Semi-Enclosed Coastal Area: The Bay
Cladocerenfauna des Kleinen Barsch-Sees, eines		W91-10534 5G
Sauren, Kalkarmen Moorweihers im Mitteleuro-	PARTICULATE MATTER	
paischen Flachland). W91-11515 2H	Scavenging Processes of Marine Particles i Osaka Bay.	n Status of Eutrophication in the Great Barrier Reef Lagoon.
		B W91-10535 5B
Analysis of Subfossil Shelled Protozoa in the Sediments of a Small Acid Forest Lake (Kleiner	Ecophysiological Significance of the Diel Bir	Potentiania i Washin Bar
Barsch-See, Northern GDR) (Analyse Subfos-	chemical Changes of Particulates Coupled with	
siler Protozoenschalen der Sedimente eines	Metabolic and Environmental Parameters	in
Kleinen Sauren Waldsees) (Kleiner Barsch-See, Nordliche DDR).	Two Trophically Different Lakes. W91-10896 2	Heavy Metal Pollution in Sediment from the H Seto Inland Sea, Japan.
W91-11516 2H		W91-10537 5B
Diatom Analysis, Late-Glacial and Post-Glacial	Remobilization of Cu from Marine Particula	te
Development of Lake Kleiner Barsch-See	Organic Matter and from Sewage. W91-10923	Scavenging Processes of Marine Particles in Osaka Bay.
(GDR)A Preliminary Note. W91-11517 2H	Measurement of the Different Forms of Zinc	W91-10538 5F
	Narragansett Bay Water Based on the Rate	
Chemical Composition of Late- and Post-Glacial	Uptake by a Chelating Resin.	Coastal Sea Area and Measures for Protection.
Sediments (Fe, Mn, P, C, N, N, H and BSi) in Lake Kleiner Barsch-See, a Bog Lake in the	W91-10926 2	K W91-10540 5E
North of GDR (Die Chemische Zusammenset-	Aerosol and Hydrometeor Concentrations as	Effect of a Spring Phytoplankton Bloom or
zung der Spat- und Postglazialsedimente des	Their Chemical Composition During Wint	Dissolved Conner Speciation in Redford Basin
Kleinen Barsch-Sees (Fe, Mn, P, C, N, H und BSi), eines Dystrophen Moorweihers im Norden	Precipitation Along a Mountain Slope: III. Siz Differentiated In-Cloud Scavenging Efficiencie	
der DDR).		B Impact of Nutrient Enrichment and Their Rela
W91-11518 2H	Flocculation of Micro-organisms.	tion to the Algal Bloom in the Adriatic Sea
PALMERTON ZINC SITE		SF W91-10544 50
Superfund Record of Decision: Palmerton Zinc Pile, PA.	PATH OF POLLUTANTS	Life Cycle Strategies of the Red Tide Causing
W91-10756 5G	Relationship Between Mean and Standard De	Flagellates Chattonella (Raphidophyceae) in the
PALYNOLOGY	ation in Precipitation Chemistry Measurement	
Geographical and Pollenanalytical Research of	Across Eastern North America. W91-10475	2B I T Protested Channels the Called
Lake Kleiner Barsch-See (Bez. Potsdam, GDR)	W91-104/5	Long Term Ecological Changes in the Gulf of
(Geographische und Pollenanalytische Untersu- chungen des Kleinen Barsch-Sees) (Bez. Pots-	Dry Deposition Washoff from Forest Tr	ree Thailand. W91-10551 51
dam, DDR).	Leaves by Experimental Acid Rainfall. W91-10476	KR .
W91-11514 2H		Benthic Faunal Succession in a Cove Organical
PAPUA NEW GUINEA	Mathematical Simulation of Pollutant Disp sion.	W91-10554 56
Off-River Storages as Sources and Sinks for		SB .
Environmental Contaminants. W91-10851 5B	New Dead Sea.	Simulation of Bioecological and Water Qualit Processes in Enclosed Coastal Seas.
		5C W91-10557 50
PARASITES Thames Water's Experiences with Cryptospori-	Matagraham and Organization in the S	eto Mariculture and Eutrophication in Jinhae Bay
dium.	Meteorology and Oceanography in the S Inland Sea.	Korea.
W91-10617 5C		2L W91-10558 5
Epidemiology of Human Cryptosporidiosis and	Runoff Characteristics of COD, BOD, C, N, a	and Study on Model Reference Adaptive Water Po
the Water Route of Infection. W91-10643 5B	P Loadings from Rivers to Enclosed Coast	
	Seas.	W91-10567 58
Isolation and Identification of Cryptosporidium from Water.	W91-10521	Environmental Assessment of Wastewate
W91-10644 5A	Pollution and Protection of Bohai Bay.	Marine Disposal of Xiaogang Zone, Ningb
Occurrence of Cryptosporidium spp. Oocysts in	W91-10522	5B W91-10570 5
Scottish Waters, and the Development of a	Water Quality Management Issues in Lingar	Totalistica of Onygen Delicions and
Fluorogenic Viability Assay for Individual	Gulf, Philippines and Some Proposed Solution W91-10523	canala bay.
Cryptosporidium Oocysts. W91-10645 5B		***************************************
	Outflow and Three-Dimensional Spreading River Water in Enclosed Bay.	Europhication Mechanisms of Coastar Seas
Occurrence and Viability of Giardia spp. Cysts in UK Waters.		2L Yamaguchi Prefecture. W91-10593 5
W91-10647 5B	Circulation and Pollutent Dispersion in Mas	
Wastewater and Giardia Cysts.	Circulation and Pollutant Dispersion in Mas Jinhae Bay of Korea.	Heavy Metals Contamination in the Polish Zon of Southern Baltic.
W91-10648 5B	W91-10526	5B W91-10597 5
Distribution of Giardia Cysts in Wastewater.	North Sea Strategies.	
W91-10649 5B		5G Sewage Treatment and Disposal Strategies Greece.
Destruction of Faecal Bacteria, Enteroviruses	5-Year Scientific Research Programme for M	
and Ova of Parasites in Wastewater Sludge by	aging Coastal Seas.	Bellistest Transport Manitoring and Bradiation
Aerobic Thermophilic and Anaerobic Mesophi-	W91-10531	2L Pollutant Transport Monitoring and Prediction by Mathematical Modelling: North Sea and A
lic Digestion. W91-10688 5D	Investigation on Turbidity and Flow Pattern	s in jacent Estuaries.
	Half-Closed Sea Area.	W91-10600
PARTICLE SIZE  Multiparameter Radar Estimation of Raindrop	W91-10532	5B East Asian Seas: Hypothetical Oil Spill Traje
Size Distribution.	Fluidization of Marine Mud by Waves.	tories.
W91-11097 7B	W91-10533	5B W91-10608

5B

### PATH OF POLLUTANTS

Computer Visualization System for Sediment Pollution in Japan. W91-10609 7C	Clostridium perfringens, as an Indicator Micro- organism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems.	Cone Penetrometer Tests and HydroPunch Sampling: A Screening Technique for Plume Definition.
Public Health Criteria for the Aquatic Environ-	W91-10686 5D	W91-10794 5A
ment: Recent WHO Guidelines and Their Appli- cation.	Atrazine Hazards to Fish, Wildlife, and Inverte- brates: A Synoptic Review. W91-10709 5C	Utility of Multiple-Completion Monitoring Wells for Describing a Solvent Plume.
W91-10620 5G	W91-10/09	W91-10800 7A
Staphylococci in Polluted Waters and in Waters of Uninhabited Areas. W91-10631 5B	Preliminary Data Summary for the Pharmaceuti- cal Manufacturing Point Source Category. W91-10710 5B	Determination of Effective Diffusion Coeffi- cients for Gaseous and Dissolved Organic Sub- stances in Soil Material Using a 'Stopped Elu-
Studies on the Bacterial Fauna of the Tamagawa	Treatability of Hazardous Chemicals in Soils: Volatile and Semivolatile Organics.	tion' Method with HPLC and GC. W91-10802 7B
River. W91-10632 5B	W91-10712 5B	Modelling Water and Solute Transport in Ma-
Bacterial Water Quality in Urban Receiving Waters.	Preliminary Data Summary for the Paint Formulating Point Source Category.	croporous Soil. I. Model Description and Sensi- tivity Analysis. W91-10803 5B
W91-10633 5B	W91-10714 5C	M. I.W W 10.1 - T 12.
Study of Campylobacter in Sewage, Sewage Sludge and in River Water.	Superfund Record of Decision: IBM (San Jose), CA.	Modelling Water and Solute Transport in Ma- croporous Soil. II. Chloride Breakthrough Under Non-Steady Flow.
W91-10634 5D	W91-10715 5G	W91-10804 2G
Relationship Between Pseudomonas aeruginosa and Bacterial Indicators in Polluted Natural Waters.	Using Oil Spill Dispersants on the Sea. W91-10716 5G	Biochemical and Histochemical Observations on Effects of Low-Level Metal Load (Lead, Cad-
W91-10635 5A	Installation of the Westbay Multiport Ground- Water Sampling System in Well 699-43-42K	mium) in Different Organ Systems of the Fresh- water Crayfish, Astacus astacus L. (Crustacea:
Enumeration of Motile Aeromonas in Valencia Coastal Waters by Membrane Filtration.	Near The 216-B-3 Pond. W91-10720 7B	Decapoda). W91-10827 5B
W91-10636 5B	Acid-Base Status of Pennsylvania Streams: Re-	Studies on the Environmental Persistence of S-
Occurrence of Legionella Bacteria in Cooling Towers in South Africa.	sults from the National Stream Survey. W91-10726 5B	31183 (Pyriproxyfen): Adsorption onto Organic Matter and Potential for Leaching through Soil. W91-10831 5B
W91-10641 5B	Comprehensive Cooling Water Study, Final	
Epidemiology of Human Cryptosporidiosis and the Water Route of Infection.	Report. Volume I: Summary of Environmental Effects.	Seasonal Variations of Aliphatic Hydrocarbons in Sardina pilchardus (Walb.) (Teleostei: Clupei-
W91-10643 5B	W91-10729 5B	dae) Tissues. W91-10839 5B
Determining Giardiasis Prevalence by Examina-	Remedial Investigation of the High Explosives	
tion of Sewage. W91-10646 5A	Burn Pit Facility, Building 829 Complex, Law- rence Livermore National Laboratory Site 300. W91-10731 5B	Fluxes and Transport of Anthropogenic and Natural Polycyclic Aromatic Hydrocarbons in the Western Mediterranean Sea.
Occurrence and Viability of Giardia spp. Cysts	Health Risk Assessment of Toluene in California	W91-10841 5B
in UK Waters. W91-10647 5B	Drinking Water. W91-10741 5C	Dispersal Dynamics of Groundwater Bacteria. W91-10843 5B
Wastewater and Giardia Cysts. W91-10648 5B	ARCHIMEDES IIa Experiment on Oil Slick Detection over the North Sea-April 1988	Rhine Rift Valley Groundwater-River Interac- tions: Evolution of their Susceptibility to Pollu-
Distribution of Giardia Cysts in Wastewater. W91-10649 5B	Measurement Results Obtained by the E-SAR System of the German Aerospace Research Es-	tion. W91-10849 5B
	tablishment. W91-10742 5B	Off-River Storages as Sources and Sinks for
Review of the Epidemiology and Diagnosis of Waterborne Viral Infections.	Urban Storm-Induced Discharge Impacts.	Environmental Contaminants.
W91-10651 5B	W91-10745 5B	W91-10851 5B
Virological Investigation of the River Elbe. W91-10652 5B	Soil Vapor Survey at the LLNL Site 300 General Services Area, Adjacent Portions of the Con-	Assimilation of Metals in Marine Copepods and its Biogeochemical Implications.  W91-10866 2L
Application of Microbial Tracers in Groundwat-	nolly and Gallo Ranches and the Site 300 Land- fill Pit 6 Area.	Debasies of House Matelain a Mad Plat of the
er Studies. W91-10671 5B	W91-10747 5B	Behavior of Heavy Metals in a Mud Flat of the Scheldt Estuary, Belgium.
Behaviour of Pathogenic Bacteria, Phages and Viruses in Groundwater During Transport and	Drinking Water Criteria Document on Xylene. W91-10757 5C	W91-10872 5B Effect of Three Primary Treatment Sewage
Adsorption.	Ground-Water Flow and Solute Movement to	Outfalls on Metal Concentrations in the Fish Cheilodactylus fuscus Collected Along the
W91-10672 5B	Drain Laterals, Western San Joaquin Valley, California. I. Geochemical Assessment.	Coast of Sydney, Australia.
Field Experiments with Microbiological Tracers in a Pore Aquifer.	W91-10768 5B	W91-10873 5B
W91-10673 5B	Ground-Water Flow and Solute Movement to	Coefficient of Pollution (p): The Southern Cali-
Transport of Microorganisms in the Underground: Processes, Experiments and Simulation	Drain Laterals, Western San Joaquin Valley, California. II. Quantitative Hydrologic Assess- ment.	fornia Shelf and Some Ocean Outfalls. W91-10874 5B
Models. W91-10674 5B	W91-10769 5B	Tar Balls on Ibeno-Okposo Beach of South-East Nigeria.
	Permeability of Soils with Organic Fluids.	W91-10876 5B
Species and Genera of Enterobacteriaceae in River Neckar and After River Bank Filtration and Their Resistance Patterns to Antibiotics and	W91-10783 5B	Bioaccumulation, Elimination and Metabolism of
Heavy Metal Salts.	Impact of Recharge Through Residual Oil Upon Sampling of Underlying Ground Water.	Triphenyltin Chloride by Early Life Stages of Minnows Phoxinus phoxinus.
W91-10675 SB	W01-10703 SB	W01_10977 5D

Mercury Body Burden and Otolith Characteris-	Leaching of Ammonium Nitrate under Field	Organic Substances in Soils and Plants after
tics of Bluefin Tuna from the Northwest Medi- terranean (Balearic Sea).	Conditions: Studies on Kinetics of Nitrification and Nitrate Reduction in an Ultisol Profile.	Intensive Applications of Sewage Sludge. W91-11126 5E
W91-10881 2L	W91-10999 5B	W91-11120
		Environmental Aspects of Landfilling Sludge.
Sorption Phenomena in Subsurface Systems: Concepts, Models, and Effects on Contaminant	Oil Spill Risk Simulation Model. W91-11001 5B	W91-11136 5E
Fate and Transport. W91-10882 5B	Political Economic Model of International Pol-	Heavy Metal Speciation in Sewage Sludge Fol- lowing a Phyto-Dewatering Treatment.
Hydrocarbons in Urban Runoff: Their Contribu-	lution. W91-11016 5B	W91-11147 5D
tion to the Wastewaters.	W91-11016	Studies for a Simultaneous Use of Liquid
W91-10885 5B	Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial	Manure and Sewage Sludge. W91-11157 5E
Volatile Organic Compounds in Two Polluted Rivers in Barcelona (Catalonia, Spain).	Evaluation.	Agrichemicals and Groundwater Protection:
W91-10887 5B	W91-11062 5B	Resources and Strategies for State and Local Management.
Hydrogeochemical Processes Controlling Sub-	Statistical Characterization of Atrazine Residues in Southwestern Ontario Great Lakes Tributar-	W91-11162 5G
surface Transport from an Upper Subcatchment of Walker Branch Watershed During Storm	ies.	Planned Studies of Agrichemicals in Ground
Events. 1. Hydrologic Transport Processes.	W91-11064 5B	and Surface Water in the Mid-Continental
W91-10907 5B	Environmental Problems and Solutions: Green-	United States. W91-11168 5B
Hydrogeochemical Processes Controlling Sub-	house Effect, Acid Rain, Pollution. W91-11066 5B	
surface Transport from an Upper Subcatchment	W31-11000	Biodegradation of Hydrocarbon Vapors in the Unsaturated Zone.
of Walker Branch Watershed During Storm	Atmospheric Carbon Dioxide and the Global	W91-11227 5B
Events. 2. Solute Transport Processes. W91-10908 5B	Carbon Cycle: The Key Uncertainties. W91-11068 5B	
		Theoretical Study of the Significance of None- quilibrium Dissolution of Nonaqueous Phase
Nitrate Removal by Denitrification in Alluvial Ground Water: Role of a Former Channel.	Ambient Air Co-Modeling in Alaska.	Liquids in Subsurface Systems.
W91-10909 5B	W91-11070 7C	W91-11228 5B
Persobilization of Cu from Marine Posticulate	Acid Precipitation: A Review.	Geostatistical Characteristics of the Borden Aq-
Remobilization of Cu from Marine Particulate Organic Matter and from Sewage.	W91-11074 5B	uifer.
W91-10923 5B	Utility Planning Model for the Study of Air Pollution Reduction.	W91-11234 2F
Distribution of Dissolved Cadmium, Lead and	W91-11079 5G	Application of a Multiprocess Nonequilibrium Sorption Model to Solute Transport in a Strati-
Copper in the Bristol Channel and the Outer		fied Porous Medium.
Severn Estuary. W91-10925 5B	Comparative Physico-Chemical Analysis of Drinking, Ground and Industrial Waste Water	W91-11239 5E
Incidence of Legionella in the Urban Environ-	of Jodhpur. W91-11083 5B	Air Quality and Deposition of Trace Elements in the Province of South-Holland.
ment in Australia. W91-10929 5B		W91-11248 5E
W91-10929 5B	Energy Transformation-Ecology Interface from a Nonlinear, Nonequilibrium Thermodynamic	Sequential Sampling of Particles, Major Ions and
Riparian Zone as a Source of Phosphorus for a	Perspective.	Total Trace Metals in Wet Deposition.
Groundwater-Dominated Lake. W91-10931 2H	W91-11085 5B	W91-11249 5I
	Assessment of Hydrogeologic Conditions with	Major Ions in Marine Rainwater With Attention
Dynamic Model of Caesium Transport in Lakes and Their Catchments.	Emphasis on Water Quality and Wastewater In-	to Sources of Alkaline and Acidic Species.
W91-10934 5B	jection, Southwest Sarasota and West Charlotte	W91-11250 5F
	Counties, Florida. W91-11087 2F	Modelling the Atmospheric Transport of Trace
Seasonal Changes in the Sanitary Bacterial Qual- ity of Water Draining a Small Upland Catch-		Metals Including the Role of Precipitating
ment in the Yorkshire Dales.	Geophysical and Chemical Investigations of Ground Water at Five Industrial or Waste-Dis-	Clouds. W91-11251 51
W91-10935 5B	posal Sites in Logan Township, Gloucester	
Bioavailability of Organic Pollutants in Boreal	County, New Jersey, 1983-87.	NOAA Satellite Data in Natural Oil Slick De tection, Otway Basin, Southern Australia.
Waters with Varying Levels of Dissolved Or-	W91-11092 5B	W91-11296 5A
ganic Material. W91-10936 5B	Calibration of a Texture-Based Model of a	Transport of the Fungicide Chlorothalonil from
	Ground-Water Flow System, Western San Joa- quin Valley, California.	Its Operational Use on a Pond Ecosystem.
Factors Affecting the Relationship Between the NBOD Values and the Amounts of Nitrogenous	W91-11101 5B	W91-11299 51
Pollutants: A Field Study on the Lee River.		Concentration of Metals in Various Larva
W91-10940 5C	Biodegradation of Chemicals at Trace Concen- trations.	Stages of Four Ephemeroptera Species.
Prospecting for Zones of Contaminated Ground-	W91-11102 5B	W91-11302 51
Water Discharge to Streams Using Bottom-Sedi-	Transport and Fate of Acetone in an Outdoor	Multimethod for Pesticides in Soil at Trac
ment Gas Bubbles. W91-10951 5B	Model Stream, Stennis Space Center near Bay	Level. W91-11309 5/
	St. Louis, Mississippi. W91-11103 5B	Distribution of Fecal Pollution Indicator Bacte
Characteristics of Rhodamine WT and Fluores- cein as Adsorbing Ground-Water Tracers.		ria in Lake Kinneret.
W91-10952 5B	Executive Summary-Assessing the Response of Emerald Lake, An Alpine Watershed in Sequoia	W91-11322 5
Delineation of a Discontinuous Aquitard with	National Park, California, to Acidification	Distribution of Chlorobenzenes in the Botton
Vertical Electrical Soundings, San Bernardino	During Snowmelt Using a Simple Hydrochemi-	Sediments of Ise Bay.
Valley, Southern California.	cal Model. W91-11112 7C	W91-11324 5
W91-10960 5B		Behavior of Chlorobenzenes in Ise Bay, Estima
Boundary Element and Particle Tracking Model	Pathway Analysis of Selected Organic Chemi-	ed from Their Concentrations in Various Env
for Advective Transport in Zoned Aquifers. W91-10997 2F	cals from Sewage to Agricultural Soil. W91-11123 5B	ronmental Media. W91-11325 5.
W91-10997 2F	W 21-11172	***************************************

### PATH OF POLLUTANTS

Pathways of Silver Uptake and Trophic Trans-	ing Sea Areas and Mass Balance Studies In Five	PEAT BOGS
fer in Estuarine Organisms. W91-11337 5B	Drainage Systems. W91-11506 5B	Fate of Silicate Minerals in a Peat Bog. W91-10789 2H
	W 91-11300	W91-10789 2H
Bioconcentration of Chlorinated Aromatic Hy-	Sources and Extent of Groundwater Contamina-	Avalon Lakes: An Environmental Opportunity.
drocarbons in Aquatic Macrophytes. W91-11338 5B	tion. W91-11546 5B	W91-11362 6G
		Impact of Carbon Dioxide and Ammonium on
Brine-Induced Advection of Dissolved Aromat-	Determination of Selenium Species in Spent Oil	the Growth of Submerged Sphagnum cuspida-
ic Hydrocarbons to Arctic Bottom Waters. W91-11340 5B	Shale Leachates by Ion Chromatography. W91-11553 5B	tum.
	W91-11553 5B	W91-11452 2H
Major Incident of Dioxin Contamination: Sedi-	Estimation of Sport Fish Harvest for Risk and	PEAT HARVESTING
ments of New Jersey Estuaries. W91-11341 5B	Hazard Assessment of Environmental Contami-	Impact of Carbon Dioxide and Ammonium on
W)1-11341	nants. W91-11556 5G	the Growth of Submerged Sphagnum cuspida-
Phenyltins in Water, Sediment, and Biota of	W91-11330	tum.
Freshwater Marinas. W91-11342 5B	Fate and Transport of Sediment-Associated	W91-11452 2H
	Contaminants. W91-11587 5B	PELAGIC ZONE
Sheep-Dips as a Source of Pollution of Fresh-	W91-11367	Estimation of Phosphorus Exchange Between
waters: A Study in Grampian Region. W91-11356 5B	PATHOGENIC BACTERIA	Littoral and Pelagic Zones During Nighttime
W91-11356 5B	Most Probable Number Method for the Enu-	Convective Circulation. W91-10863 2H
Simazine Concentrations in a Stream Draining	meration of Legionella Bacteria in Water. W91-10640 5A	W91-10803 2H
an Agricultural Catchment.	W91-10640 5A	PENNSYLVANIA
W91-11364 4C	Occurrence of Legionella Bacteria in Cooling	Statistical Analysis of Errors in Estimating Wet
Dynamics of Pesticides in Tropical Conditions.	Towers in South Africa.	Deposition Using Five Surface Estimation Algo-
1. Kinetic Studies of Volatilization, Hydrolysis,	W91-10641 5B	rithms. W91-10474 7B
and Photolysis of Dieldrin and Alpha and Beta Endosulfan.	Growth and Inactivation Kinetics of Mycobac-	/B
W91-11375 5B	teria in Biofilms.	Acid-Base Status of Pennsylvania Streams: Re-
	W91-10642 5B	sults from the National Stream Survey.
Microbial Dechlorination of the Herbicide Me-	Direct Detection of Enteropathogenic Bacteria	W91-10726 5B
tolachlor. W91-11377 5B	in Estuarine Water Using Nucleic Acid Probes.	Superfund Record of Decision: Palmerton Zinc
W91-113//	W91-10664 5A	Pile, PA.
Groundwater Contamination By Anthropogenic	Debasions of Debassis Destais Discussed	W91-10756 5G
Organic Compounds From Waste Disposal	Behaviour of Pathogenic Bacteria, Phages and Viruses in Groundwater During Transport and	Superfund Record of Decision: Whitmoyer Lab-
Sites: Transformations and Behavior. W91-11378 5B	Adsorption.	oratories, PA.
W71-11376	W91-10672 5B	W91-11582 5G
Migration and Treatment of a Dense Aqueous	Chlorine Resistance of Motile Aeromonas spp.	
Contaminant Source and Plume. W91-11380 5G	W91-10678 5F	Nutrient Loading Status of the Conestoga River Basin, 1985-1989.
W91-11380	W 91-100/0	W91-11599 5G
Trace Element Distribution in Surficial Sedi-	Occurrence of V. cholerae 0:1 Non-Toxigenic in	1171-11377
ments of the Northern Tyrrhenian Sea: Contri-	Wastewaters from Sao Paulo, Brazil. W91-10685 5D	Assessment of Agricultural Nutrient Point
bution to Heavy-Metal Pollution Assessment. W91-11444 5A	W91-10665	Source Discharge from Tile Drains, Spring and Overland Runoff from Two Farms, Dauphin
	Survival of Pathogenic Bacteria in an Adverse	County, Pennsylvania.
Heavy Metal Distribution in the Godvari River	Environment.	W91-11600 5B
Basin. W91-11445 5B	W91-10692 5D	PPR LODGE LODGE
	Pulsed Field Electrophoresis of Genomic Re-	PERACETIC ACID  Activity of Peracetic Acid on Sewage Indicator
Lead Sorption in Calcareous Soils.	striction Fragments for the Detection of Noso-	Bacteria and Viruses.
W91-11453 5B	comial Legionella pneumophila in Hospital Water Supplies.	W91-10683 5D
226-Ra and Other Radionuclides in Water,	W91-10836 5A	BERLE URACE
Vegetation, and Tissues of Beavers (Castor cana-		PERMAFROST  Analysis of Ground-Probing Radar Data: Pre-
densis) from a Watershed Containing U Tailings Near Elliot Lake, Canada.	PATHOGENS	dictive Deconvolution.
W91-11454 5B	Causes of Waterborne Outbreaks in the United States.	W91-10782 8G
	W91-10616 5B	
Impact of a Pulse Application of Permethrin on		PERMEABILITY  Permeability of Sails with Organia Fluids
the Macroinvertebrate Community of a Head- water Stream.	Use of Risk Assessment for Development of	Permeability of Soils with Organic Fluids. W91-10783 5B
W91-11456 5C	Microbial Standards. W91-10619 5G	W 91-10/83
Carlos de Porte de Company	W71-10017	Relationship of Regional Water Quality to Aqui-
Studies on the Effects of Some Organic Pollut- ants on the Heavy Metal Transport in an Indian	Virological Investigation of the River Elbe.	fer Thermal Energy Storage.
Soil.	W91-10652 5B	W91-11082 5C
W91-11457 5C	Contribution for the Study of New Pathogenic	Hydrology of the Floridan Aquifer System in
Badon in Homes Following Its Badustian in a	Indicators Removal from W. S. P. in Portugal.	East-Central Florida.
Radon in Homes Following Its Reduction in a Community Water Supply.	W91-10689 5D	W91-11113 2F
W91-11464 5B	PEACE RIVER	Graphical Method for Determining the Coeffi-
	Land Use, Water Use, Streamflow Characteris-	cient of Consolidation cv from a Flow-Pump
Forest Industry Wastewaters. W91-11467 5D	tics, and Water-Quality Characteristics of the	Permeability Test.
	Charlotte Harbor Inflow Area, Florida.	W91-11393 7C
Organohalogens of Natural and Industrial Origin	W91-10771 4C	PERMETHRINS
In Large Recipients of Bleach-Plant Effluents. W91-11505 5B	PEAT	Impact of a Pulse Application of Permethrin on
	Groundwater Flow and the Metal Content of	the Macroinvertebrate Community of a Head-
Distribution of Halogenated Organic Com-	Peat.	water Stream.
pounds (AOX)Swedish Transport to Surround-	W91-10902 2F	W91-11456 5C

PERMITS	Characteristics of Rhodamine WT and Fluores-	Sheep-Dips as a Source of Pollution of Fresh-
Permitting Nonpoint Sources: Programs, Provi-	cein as Adsorbing Ground-Water Tracers.	waters: A Study in Grampian Region.
sions, Problems and Potential.	W91-10952 5B	W91-11356 5B
W91-10730 5G		
	Pesticides and Drinking Water Information: A	Dynamics of Pesticides in Tropical Conditions.
Toxics Reduction: The Legal Framework.	Perspective from EPA's National Pesticide	1. Kinetic Studies of Volatilization, Hydrolysis,
W91-11538 6E	Survey.	and Photolysis of Dieldrin and Alpha and Beta
	W91-11173 5D	Endosulfan.
Managing Toxic Substances in Municipal		W91-11375 5B
Wastewater Treatment Plants.	National Pesticide Usage Data Base.	
W91-11540 5D	W91-11176 7C	PHARMACEUTICAL WASTES
	Crop Data Management Systems, Inc. Meeting	Preliminary Data Summary for the Pharmaceuti-
New Storm Water Regulations Require Signifi-		cal Manufacturing Point Source Category.
cant Compliance Actions by Both Industries and	California's Pesticide Regulation Challenge.	W91-10710 5B
Municipalities.	W91-11177 5G	
W91-11541 5D	Funding New York State's Integrated Pest Man-	PHENOLIC PESTICIDES
	agement Program.	Comparison of Amperometric and UV-Spectro-
PERSIAN GULF	W91-11180 6C	photometric Monitoring in the HPLC Analysis
New Dead Sea.	W91-11100 0C	of Pesticides.
W91-10504 5C	Wellhead Protection in Massachusetts: Protect-	W91-11306 5A
	ing Public Water Supplies from Pesticide Im-	W 91-11300
PESSES CHEMICAL SITE	pacts.	PHENOLICS
Superfund Record of Decision: Pesses Chemical,	W91-11182 5G	Anaerobic Treatability of a Phenolic Coal Con-
TX.	W 91-11102 3G	
W91-10718 5G	Home Water Treatment: Remediating Aldicarb	version Wastewater After Diisopropyl Ether
	Contamination in Suffolk County, New York.	Extraction.
PESTICIDE DRIFT	W91-11189 5F	W91-10939 5D
Contamination of Ponds by Fenitrothion during	W 71-11107 51	PATRICE A
Forest Spraying.	Returnable Pesticide Containers: Maine's Depos-	PHENOLS
W91-11298 5B	it and Collection System.	Accumulation of Refractory 4-Nonylphenol
	W91-11191 5G	During Mesophilic Anaerobic Sludge Stabiliza-
PESTICIDE RESIDUES	W31-11131 3G	tion.
Application of HPLC Column-Switching in Pes-	Oregon Pesticide Container Initiative.	W91-10707 5D
ticide Residue Analysis.	W91-11192 5E	
W91-11308 5A		Flow-Rate Variated HPLC-/EC-Determination
W 51-11300	Minnesota Waste Pesticide Collection Pilot	of Phenois.
Determination of Herbicide Residues in Soil in	Project.	W91-11257 5A
the Presence of Persistent Organochlorine Insec-	W91-11193 5E	
ticides.		Sheep-Dips as a Source of Pollution of Fresh-
W91-11310 5A	Urban Pesticide Waste Management: Strategies	waters: A Study in Grampian Region.
	for Education and Collection.	W91-11356 5B
Solid-Phase Extraction for Multi-Residue Analy-	W91-11194 5E	
sis of Some Triazole and Pyrimidine Pesticides		Oxic Fluidized-Bed Treatment of Dichlorophen-
in Water.	Pesticide Rinseate Management Plan.	ols.
W91-11313 5A	W91-11195 5G	W91-11485 5D
***************************************		
Behavior of the Fungicide MBAMT in Water.	Developing a Groundwater Training Program	Factors Affecting the Removal and Discharge
W91-11315 5A	for Pesticide Users.	of Organic Chlorine Compounds at Activated
	W91-11199 5G	Sludge Treatment Plants.
PESTICIDE TOXICITY	Plantale Besticide Water Coulity Education	W91-11498 5D
Effect of Pesticide Treatments on Nontarget Or-	Florida's Pesticide Water Quality Education	
ganisms in California Rice Paddies.	Program.	Formation of Chlorophenols and Related Com-
W91-10835 5C	W91-11202 5G	pounds In Natural and Technical Chlorination
	Capillary Column Gas Chromatography With	Processes.
Impact of a Pulse Application of Permethrin on	Nitrogen-Phosphorus Detection for Determina-	W91-11508 5E
the Macroinvertebrate Community of a Head-	tion of Nitrogen-and Phosphorus-Containing	
water Stream.	Pesticides in Finished Drinking Waters: Collabo-	Anaerobic Degradation of PCP and Phenol In
W91-11456 5C		Fixed-Film Reactors: The Influence of an Addi-
	rative Study.	tional Substrate.
Effects of Chlornitrofen, a Herbicide, on Repro-	W91-11259 5A	W91-11512 5D
duction of Brachionus urceolaris (Rotatoria)	Descondential of Undrophilis and Undropho	
Through Water and Food (Chlorella).	Preconcentration of Hydrophilic and Hydropho- bic Pesticides from Aqueous Solutions and Ex-	PHENOXY ACID HERBICIDES
W91-11458 5C	traction of Residues Using the Polymeric Sor-	Use of Non-Persistent Herbicides, Glyphosate
		and 2,4-D Amine, to Control Riparian Stands of
PESTICIDES	bent Wofatit Y 77.	Japanese Knotweed (Reynoutria japonica
Preliminary Data Summary for the Pesticide	W91-11305 5A	Houtt).
Chemicals Point Source Category.	Comparison of Amperometric and UV-Spectro-	W91-10852 4A
W91-10739 5B	photometric Monitoring in the HPLC Analysis	W91-10832
		Determination of Chlorinated Phenoxy Acid
Studies on the Environmental Persistence of S-	of Pesticides.	and Ester Herbicides in Soil and Water by
31183 (Pyriproxyfen): Adsorption onto Organic	W91-11306 5A	Liquid Chromatography Particle Beam Mass
Matter and Potential for Leaching through Soil.	Multi-Residue-Analysis of Pesticides by HPLC	
W91-10831 5B	after Solid Phase Extraction.	Spectrometry and Ultraviolet Absorption Spec
	W91-11307 5A	trophotometry.
Effect of Pesticide Treatments on Nontarget Or-	W71-1130/ JA	W91-10893 5A
ganisms in California Rice Paddies.	Multimethod for Pesticides in Soil at Trace	DUIT IDDINES
W91-10835 5C	Level.	PHILIPPINES
	W91-11309 5A	Water Quality Management Issues in Lingayer
Sensitive High-Performance Liquid Chromato-	177-11307 JA	Gulf, Philippines and Some Proposed Solutions
graphic Analysis for Toxicological Studies with	Strategy for Pesticide Control in Ground Water	W91-10523 5C
Carbaryl.	and Drinking Water.	
W91-10920 5A	W91-11312 5A	PHOSPHATES
W 21-10920	W/1-11312	Ion Concentrations in Interstitial Water as Indi
Transformation of (C-14)-2,4-Dichlorophenol in	Simple Spectrophotometric Determination of	cators for Phosphorus Release Processes and
Saskatchewan Soils.	Endosulfan in River Water and Soil.	Reactions.
W01 10022 5B	W91-11314 5A	W91-10888 2F

# **PHOSPHATES**

Influence of pH on Phosphate Release from Sediments.	PHOSPHORUS REMOVAL Practical Experience with Biological Removal	Zooplankton Effects on Phytoplankton in Lakes of Contrasting Trophic Status.
W91-11327 2H	of Phosphorus from Pulp and Paper Mill Ef- fluents.	W91-10859 2H
Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.	W91-11496 5D	Effects of pH and Aluminum on the Growth of the Acidophilic Diatom Asterionella ralfsii var.
W91-11332 5C	PHOTOACTIVATION Acute Phototoxicity of Harbor and Tributary	americana. W91-10862 2H
Natural Phosphate Source for Lake Waccamaw, North Carolina, USA.	Sediments from Lower Lake Michigan. W91-10977 5C	Coulometric Measurement of Primary Produc-
W91-11405 2H		tion, with Comparison against Dissolved
	PHOTOLYSIS	Oxygen and 14-C Methods in a Seasonal Study.
PHOSPHORUS	Behavior of the Fungicide MBAMT in Water.	W91-10868 2L
Runoff Characteristics of COD, BOD, C, N, and	W91-11315 5A	Per a critical de la contra del la contra del la contra del la contra de la contra del la contra de la contra de la contra del la contra de la contra del la cont
P Loadings from Rivers to Enclosed Coastal	PHOTOMETRY	Effect of Hydroelectric Stations on Water Qual-
Seas.	Secchi Disk and Photometer Estimates of Light	ity and Development of Phytoplankton in the Lower Pools of Reservoirs.
W91-10521 5B	Regimes in Alaskan Lakes: Effects of Yellow	W91-11289 6G
Phosphorus in the Truckee River Between Vista	Color and Turbidity. W91-10860 2H	PHYTOTOXICITY
and Patrick, Storey and Washoe Counties,	W 91-10000 2H	Ultrastructural and Biochemical Effects of Cad-
Nevada, August 1984.	Determination of Chlorinated Phenoxy Acid	mium on the Aquatic Fern Marsilea minuta
W91-10763 5A	and Ester Herbicides in Soil and Water by	Linn.
Estimation of Phosphorus Exchange Between	Liquid Chromatography Particle Beam Mass	W91-10829 5C
Littoral and Pelagic Zones During Nighttime	Spectrometry and Ultraviolet Absorption Spec-	,
Convective Circulation.	trophotometry.	PIEDMONT PHYSIOGRAPHIC PROVINCE
W91-10863 2H	W91-10893 5A	Evaluation of Site-Selection Criteria, Well
W91-10803	THE OWNER WHEN THE	Design, Monitoring Techniques, and Cost Anal-
Delay in Lake Recovery Caused by Internal	PHOTOSYNTHESIS	ysis for a Ground-Water Supply in Piedmont
Loading.	Coulometric Measurement of Primary Produc-	Crystalline Rocks, North Carolina.
W91-10886 2H	tion, with Comparison against Dissolved	W91-11596 2F
***************************************	Oxygen and 14-C Methods in a Seasonal Study.	
Ion Concentrations in Interstitial Water as Indi-	W91-10868 2L	PINE TREES
cators for Phosphorus Release Processes and	PHYSICAL PROPERTIES	Ozone, Acidic Precipitation, and Soil Mg Ef-
Reactions.	Causes of Degradation of Chemical and Physical	fects on Growth and Nutrition of Loblolly Pine
W91-10888 2K	Properties of Chernozems Irrigated with Non-	Seedlings. W91-10918 5C
	mineralized Water.	W91-10918 5C
Role of Phosphorus Cycling in Algal Metabo-	W91-10913 2G	Rainfall Interception by Trees of Pinus radiata
lism and Algal Succession in Lake Donghu,		and Eucalyptus viminalis in a 1300 mm Rainfall
China.	Effect of Long-Term Application of Fertilizers	Area of Southeastern New South Wales: I.
W91-10897 5C	on the Agrophysical Properties of an Irrigated	Gross Losses and Their Variability.
Riparian Zone as a Source of Phosphorus for a	Light-Chestnut Soil.	W91-11345 2D
Groundwater-Dominated Lake.	W91-10914 2G	
W91-10931 2H	Physical Properties of Irrigated Chernozems of	Rainfall Interception by Trees of Pinus radiata
1171-10751	the Southern Ukraine.	and Eucalyptus viminalis in a 1300 mm Rainfall
Great Lakes Total Phosphorus Model: Post	W91-10915 2G	Area of Southeastern New South Wales: II. In-
Audit and Regionalized Sensitivity Analysis.	117110710	fluence of Wind-Borne Precipitation.
W91-10974 2H	Sorption Properties and Moisture Hysteresis of	W91-11346 2D
	Soils.	PIPELINES
Phosphorus from Internal Sources in the Lau-	W91-10916 2G	Channel Tunnel and Its Impact on the Folkes-
rentian Great Lakes, and the Concept of Thresh-	PHYSICOCHEMICAL TREATMENT	tone and District Water Company.
old External Load.		W91-11363 4C
W91-10982 5B	Application of Physicochemical Treatment to an Overloaded Sewage Works.	W71-11505
Ban on Phosphorus in Detergents: The Effects	W91-11357 5D	Simazine Concentrations in a Stream Draining
on the Phosphorus Contents of Swiss Sewage	W 21-11331	an Agricultural Catchment.
Sludges and on the Efficiency of Phosphorus	PHYSIOLOGICAL ECOLOGY	W91-11364 4C
Elimination by Sewage Treatment Plants.	Ecophysiological Significance of the Diel Bio-	DEDDE
W91-11142 5D	chemical Changes of Particulates Coupled with	PIPES
30	Metabolic and Environmental Parameters in	Scour at Cantilevered Pipe Outlets, Plunge, Pool
Studies for a Simultaneous Use of Liquid	Two Trophically Different Lakes.	Energy Dissipator Design Criteria. W91-10722 8B
Manure and Sewage Sludge.	W91-10896 2H	**************************************
W91-11157 5E	Rotifers of the Genus SynchaetaAn Important	PIPING
Markey France & Committee of the Committ	Component of the Zooplankton in the Coastal	Piping and Pseudokarst in Drylands.
Phosphorus Losses from the Epilimnion in	Waters of the Southern Baltic.	W91-11561 2F
Rimov Reservoir.	W91-11519 2L	
W91-11401 2H		PLANKTON
Criteria for Nutrient-Balanced Operation of Ac-	PHYTOPLANKTON	Changes and Stress Signs in Plankton Communi-
tivated Sludge Process.	Effect of a Spring Phytoplankton Bloom on	ties as a Result of Man-Induced Perturbations in
W91-11493 5D	Dissolved Copper Speciation in Bedford Basin.	Enclosed Coastal Seas (Mediterranean, Baltic).
30	W91-10543 5B	W91-10547 5C
Nitrogen and Phosphorus Limits for Nutrient	Growth Potentials of Red Tide Phytoplankters	Primary Productivity and Plankton Communi-
Deficient Industrial Wastewaters.	in Coastal Seawater by AGP Assay.	ties in a Two-Reservoir Series.
W91-11494 5D		W91-10815 2H
	W91-10548 5A	177-10013 2H
Practical Experience with Biological Removal	Seasonal Changes of Organic Carbon and Nitro-	Impact of Physico-chemical Complexes on
of Phosphorus from Pulp and Paper Mill Ef-	gen Production by Phytoplankton in the Estuary	Plankton Density in Dhir Beel of Assam.
fluents.	of River Tamagawa.	W91-11527 2H
W91-11496 5D	W91-10604 5B	
Nutrient Leading Status of the Court of		PLANNING
Nutrient Loading Status of the Conestoga River	Trace Metal Interactions with Marine Phyto-	Modern Environmental Assessment Procedures
Basin, 1985-1989.	plankton.	for Enclosed Seas.
W91-11599 5G	W91-10853 2L	W91-10564 6G

		POLLUTANT IDENTIFICATION
PLANT GROWTH	POLAND	Pluorogenic Viability Assay for Individual
Ozone, Acidic Precipitation, and Soil Mg Ef- fects on Growth and Nutrition of Loblolly Pine	Heavy Metals Contamination in the Polish Zone of Southern Baltic.	Cryptosporidium Oocysts. W91-10645 5B
Seedlings. W91-10918 5C	W91-10597 5B	Determining Giardiasis Prevalence by Examina-
Tree-Ring Reconstructed Sunshine Duration	Coal Mine Waters and Their Influence on the Purity Ecological State of River and the Fish	tion of Sewage. W91-10646 5A
over Central USA. W91-10972 2I	Production. W91-10605 5B	Occurrence and Viability of Giardia spp. Cysts
Effects of Acid Rain on Epiphytic Orchid	POLICY MAKING	in UK Waters. W91-10647 5E
Growth. W91-11076 5C	Red River Basin Grass Roots Policy Process. W91-11185 6B	Improvement of the Zeta-Plus Filter Method for Concentration of Viruses from Water.
Influence of Leaf Leachate-Enriched Water of Neem (Azadirachta indica A. Juss.) and Shirish	POLIOVIRUS  Detection of Poliovirus in Water by Direct Iso-	W91-10655 5A
(Albizzia lebbek Benth.) on the Growth of Eichhornia crassipes (Mart.) Solms.	lation of the RNA and Hybridization with Gene Probes.	Rotavirus Detection: A Problem that Need Concentration.
W91-11449 2I	W91-10666 5A	W91-10656 3/
Impact of Carbon Dioxide and Ammonium on the Growth of Submerged Sphagnum cuspida-	Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water.  W91-10667 5A	Recovery of Enterovirus from Primary Sludg Using Three Elution Concentration Procedures W91-10657
tum. W91-11452 2H	Comparative Study on Adsorption Mechanisms	Concentration of Hepatitis A Virus in Environ
PLANT PHYSIOLOGY Impact of Carbon Dioxide and Ammonium on	of RNA-F-Specific Coliphages and Poliovirus in Activated Sludge Process.	mental Samples. W91-10658 5/
the Growth of Submerged Sphagnum cuspida-	W91-10694 5D	Detection of Rotavirus in South African Water
tum. W91-11452 2H	POLITICAL ASPECTS Political Economic Model of International Pol-	A Comparison of a Cytoimmunolabelling Technique with Commercially Available Immunoa
LANT POPULATIONS	lution. W91-11016 5B	says. W91-10660 55
Proximate Composition and Nutrient Elements in the Unusual Algal Jellies of Lake Oguta in	Water Management in the 21st Century.	Difficulty of Using Coliphages as 'Indicator
Southern Nigeria. W91-11408 2H	W91-11206 4A	and 'Index' Organisms. W91-10661 5.
LANT-WATER RELATIONSHIPS Microclimatological Investigations in the Tropi-	Dynamics of Water Policy. W91-11212 6E	Direct Detection of Enteropathogenic Bacter in Estuarine Water Using Nucleic Acid Probe
cal Alpine Scrub of Maui, Hawaii: Evidence for a Drought-Induced Alpine Timberline.	Managing Water Resources in Latin America. W91-11385 6B	W91-10664 S
W91-10878 2I	Land Tenure Issues in Watershed Development. W91-11569 6F	Detection of Hepatitis A Virus and Other Ente oviruses in Wastewater and Surface Water San
Effects of Drought Stress and Simulated Acidic Rain on Foliar Conductance of Zea mays L.	POLLEN	ples by Gene Probe Assay. W91-10665
W91-10919 5C Microwave Transmission, a New Tool in Forest Hydrological Research.	Geographical and Pollenanalytical Research of Lake Kleiner Barsch-See (Bez. Potsdam, GDR) (Geographische und Pollenanalytische Untersu- chungen des Kleinen Barsch-Sees) (Bez. Pots-	Detection of Poliovirus in Water by Direct Is lation of the RNA and Hybridization with Ge Probes.
W91-10995 2I PLANTING MANAGEMENT	dam, DDR). W91-11514 2H	W91-10666 S Application of a Poliovirus cDNA Probe for t
Revegetation Technologies.		Detection of Enteroviruses in Water.
W91-11568 4D	POLLUTANT IDENTIFICATION Growth Potentials of Red Tide Phytoplankters	W91-10667
PLUG FLOW Influence of Reactor Mixing Characteristics on	in Coastal Seawater by AGP Assay. W91-10548 5A	Detection of Rotaviruses in Water by Ge Probes. W91-10668
the Rate of Nitrification in the Activated Sludge Process.	Marine Pollution Bioassay by Using Sea Urchin Eggs in the Tanabe Bay, Wakayama Prefecture,	Growth of Clinical Isolates of Astrovirus in
W91-10932 5D PLUMBING	Japan, 1970-1987. W91-10602 5A	Cell Line and the Preparation of Viral RN W91-10669
Water Use Reductions from Retrofitting Indoor		PCR and Environmental Monitoring: The W
Water Fixtures. W91-10811 6D	Microbiological Methods for Safety Testing of Drinking Water Directly Reclaimed from Wastewater.	Forward. W91-10670
PLUMES	W91-10613 5A	
Cone Penetrometer Tests and HydroPunch Sampling: A Screening Technique for Plume	Bacteriological Suitability of Water from Basrah Wells for Drinking.	Salmonella Detection in Sewage Waters Us Fluorescent Antibodies. W91-10687
Definition. W91-10794 5A	W91-10629 5A	Assessment of Methods for the Microbiolog
Utility of Multiple-Completion Monitoring	Miniaturized Fluorogenic Assays for Enumera- tion of E. coli and Enterococci in Marine Water.	Analysis of Shellfish. W91-10695
Wells for Describing a Solvent Plume. W91-10800 7A	W91-10639 5A	Comparison of Two Methods for the Recov
Geostatistical Characteristics of the Borden Aq-	Most Probable Number Method for the Enu- meration of Legionella Bacteria in Water.	of Rotavirus from Mussels and Oysters. W91-10697
uifer. W91-11234 2F	W91-10640 5A	Comparison of Methods for the Isolation of
POINT LOOKOUT SANDSTONE	Isolation and Identification of Cryptosporidium from Water.	Wide Range of Viruses from Shellfish. W91-10698
Hydrogeology of the Point Lookout Sandstone in the San Juan Structural Basin, New Mexico, Colorado, Arizona, and Utah.	W91-10644 5A  Occurrence of Cryptosporidium spp. Oocysts in	Field Sampling of Residual Aviation Gasoline Sandy Soil.
	CAZUITENCE OF CTVDIOSDOTIGIUM SDD. COCYSIS IN	Juney John.

### **POLLUTANT IDENTIFICATION**

M. d. 10 . d		DOLLIE LA DE LA CAR
Method for Assessing Residual NAPL Based on	Determination of Nitroaromatics and Nitramines in Ground and Drinking Water by Wide-Bore	POLLUTANT LOAD
Organic Chemical Concentrations in Soil Sam- ples.	Capillary Gas Chromatography.	Techniques for Estimation of Storm-Runoff
W91-10797 5A	W91-11262 5A	Loads, Volumes, and Selected Constituent Con- centrations in Urban Watersheds in the United
		States.
Occurrence of Appendix IX Organic Constituents in Disposal Site Ground Water.	Marine Monitoring in Heterogeneous Environ- ments.	W91-11094 5B
W91-10801 5B	W91-11264 5A	Nutrient Loading Status of the Conestoga River
Spectrophotometric Determination of Nitrite in	Development of an Enzyme Immunoassay for	Basin, 1985-1989.
Polluted Waters Using 3-Nitroaniline.	the Determination of Metazachlor.	W91-11599 5G
W91-10823 5A	W91-11295 5A	DOLL LITANT SCANENCING
Simultaneous Ultraviolet Spectrophotometric	Preconcentration of Hydrophilic and Hydropho-	POLLUTANT SCAVENGING Scavenging Processes of Marine Particles in
Determination of Nitrate and Nitrite in Water.	bic Pesticides from Aqueous Solutions and Ex-	Osaka Bay.
W91-10824 5A	traction of Residues Using the Polymeric Sor-	W91-10538 5B
Patella vulgata, Mytilus minimus and Hyale pre-	bent Wofatit Y 77.	
vosti as Bioindicators for Pb and Se Enrichment	W91-11305 5A	POLLUTANT TRANSPORT Organohalogens of Natural and Industrial Origin
in Alexandria Coastal Waters.	Comparison of Amperometric and UV-Spectro-	In Large Recipients of Bleach-Plant Effluents.
W91-10875 5A	photometric Monitoring in the HPLC Analysis	W91-11505 5B
Determination of Chlorinated Phenoxy Acid	of Pesticides. W91-11306 5A	District
and Ester Herbicides in Soil and Water by	W31-11300	Distribution of Halogenated Organic Com- pounds (AOX)—Swedish Transport to Surround-
Liquid Chromatography Particle Beam Mass	Multi-Residue-Analysis of Pesticides by HPLC	ing Sea Areas and Mass Balance Studies In Five
Spectrometry and Ultraviolet Absorption Spec-	after Solid Phase Extraction.	Drainage Systems.
trophotometry. W91-10893 5A	W91-11307 5A	W91-11506 5B
	Determination of Herbicide Residues in Soil in	
Chromatographic Separation of Arsenic Species	the Presence of Persistent Organochlorine Insec-	POLLUTION INDEX
with Sodium Bis(trifluoroethyl)dithiocarbamate Chelation.	ticides.	Coefficient of Pollution (p): The Southern Cali-
W91-10894 5A	W91-11310 5A	fornia Shelf and Some Ocean Outfalls. W91-10874 5B
W71-10074	Analysis of 10 Selected Herbicides in Water.	W 91-108/4
Sensitive High-Performance Liquid Chromato-	W91-11311 5A	Application of the DRASTIC Mapping System
graphic Analysis for Toxicological Studies with	Stanton for Posticide Control in Control Water	for Evaluating Ground Water Pollution Poten-
Carbaryl. W91-10920 5A	Strategy for Pesticide Control in Ground Water and Drinking Water.	tial in Ohio.
	W91-11312 5A	W91-11178 5B
Estimation of Trace Metals Levels in Power and		Usefulness of Various Numerical Methods for
Industrial Waste Water of Jodhpur by Differen-	Solid-Phase Extraction for Multi-Residue Analy-	Assessing the Specific Effects of Pollution on
tial Pulse Anodic Stripping Voltammetry. W91-11084 5A	sis of Some Triazole and Pyrimidine Pesticides in Water.	Aquatic Biota.
W31-11004	W91-11313 5A	W91-11406 5C
Chemical Properties of Sewage Sludges Pro-		POLLUTION LOAD
duced in the Valencian Area (Spain).	Simple Spectrophotometric Determination of	Evaluation of Primary Production Loads and
W91-11159 5A	Endosulfan in River Water and Soil. W91-11314 5A	Their Control in Enclosed Seas.
Use of 2,2-Dimethoxypropane for the Direct	W71-11514 JA	W91-10524 5G
Gas Chromatographic-Mass Spectrometric De-	Methyl and Butyltin Compounds in Water and	***************************************
termination of Some Organic Compounds in	Sediments of the Rhine River.	Countermeasures Against Water Pollution in
Water. W91-11245 5A	W91-11335 5B	Enclosed Coastal Seas in Japan.
W71-11245	Quantitative Determination of Acrylonitrile in	W91-10572 5G
Organotin Stability During Storage of Marine	an Industrial Effluent by Ambient-Temperature	Controlling Effect of the Planned Management
Waters and Sediments.	Purge and Trap Capillary GC-MS and by	of the Environment in the Kagoshima Bay or
W91-11255 5A	Heated Purge and Trap GC-FID.	the Pollutant Load.
Continuous Flow Thin-Layer Headspace	W91-11336 5A	W91-10579 5G
(TLHS) Analysis. I. Conductometric Determi-	Low Cost Flow Injection Analysis for Cadmium	Computer Visualization System for Sediment
nation of Volatile Organic Halogens (VOX) in	Using 2-(2-benzothiazolylazo) -4,5-Dimethyl-	Pollution in Japan.
Tap Water. W91-11256 5A	phenol. W91-11379 5A	W91-10609 70
W71-11230	W91-113/9	
Flow-Rate Variated HPLC-/EC-Determination	Latex Agglutination for the Detection of Cam-	Great Lakes Total Phosphorus Model: Pos
of Phenois.	pylobacter Species in Water.	Audit and Regionalized Sensitivity Analysis. W91-10974
W91-11257 5A	W91-11465 5A	W91-109/4
Capillary Column Gas Chromatography With	Monitoring of Organochlorine Compounds In	Phosphorus from Internal Sources in the Lau
Nitrogen-Phosphorus Detection for Determina-	Finnish Inland Waters Polluted by Pulp and	rentian Great Lakes, and the Concept of Thresh
tion of Nitrogen-and Phosphorus-Containing	- upon minutes of the manufactures	old External Load.
Pesticides in Finished Drinking Waters: Collabo- rative Study.		W91-10982 5H
W91-11259 5A		POLYCHLORINATED BIPHENYLS
	High-Performance Liquid Chromatographic	Polychlorinated Biphenyls in Dated Sedimen
Direct Aqueous Injection-Liquid Chromatogra-	oracj on oxidinon riceaeth or Eighin and	Cores from Green Bay and Lake Michigan.
phy With Post-Column Derivatization for De- termination of N-Methylcarbamoyloximes and	Training Chopeanices.	W91-10979 51
N-Methylcarbamates in Finished Drinking		0-1-01-1-1-1-1
Water: Collaborative Study.	Direct Sampling Ion Trap Mass Spectrometry	Organic Substances in Soils and Plants afte
W91-11260 5A	for the Rapid Determination of Volatile Organ-	Intensive Applications of Sewage Sludge. W91-11126
Liquid Chromatographic Determination of Gly-	ics in Environmental Matrices.	W >1-11120
phosate and Aminomethylphosphonic Acid		Mechanisms of Resistance to Polychlorinate
(AMPA) in Environmental Water: Collaborative		Biphenyls (PCB) in Two Species of Marine Dia
Study.	300 Area Process Ponds.	toms.
W91-11261 5A	W91-11583 5G	W91-11562 50

POLYCYCLIC AROMATIC HYDROCARBONS Fluxes and Transport of Anthropogenic and Natural Polycyclic Aromatic Hydrocarbons in the Western Mediterranean Sea.	POTOMAC ESTUARY Rise and Fall of the Potomac River Striped Bass Stock: A Hypothesis of the Role of Sewage. W91-11529	Canadian Atlantic Storms Program: Progress and Plans of the Meteorological Component. W91-10943
W91-10841 5B		Tree-Ring Reconstructed Sunshine Duration over Central USA.
Hydrocarbons in Urban Runoff: Their Contribu-	POWDERED ACTIVATED CARBON Evaluation of Full Scale Activated Sludge Sys-	W91-10972 21
tion to the Wastewaters. W91-10885 5B	tems Utilizing Powdered Activated Carbon Addition with Wet Air Regeneration.	Precipitation in Britain: An Analysis of Area-
POLYELECTROLYTES	W91-11099 5D	Average Data Updated to 1989. W91-10973 2B
Influence of Polyelectrolyte Characteristics on	POWERPLANTS	
Sludge Conditioning (Lab Evaluations). W91-10701 5D	Interrelations Between Amoebae and Bacteria in the Moselle River, France.	Great lakes Hydrological Impacts of 2xCO2 Climate Change. W91-11061 5C
BONDS	W91-10650 5B	
PONDS  Contamination of Ponds by Fenitrothion during	Environmental Control Impacts of Selected Al-	Simulation of Precipitation by Weather Type
Forest Spraying.	ternate Fuels on Existing Power Plants. W91-11078 5G	Analysis. W91-11230 2B
W91-11298 5B	W91-110/6	Efficiency With Which Drizzle and Precipita-
Transport of the Fungicide Chlorothalonil from Its Operational Use on a Pond Ecosystem.	PRAIRIES Upstream Extirpation of Four Minnow Species	tion Sized Drops Collide With Aerosol Particles.
W91-11299 5B	Due to Damming of a Prairie Stream. W91-11535 6G	
POPULATION DENSITY	W91-11555	Rainfall Interception by Trees of Pinus radiata and Eucalyptus viminalis in a 1300 mm Rainfall
Alternating Dynamics of Rotifers and Daphnia	PRECIPITATION	Area of Southeastern New South Wales: I.
magna in a Shallow Lake. W91-10898 2H	Increased Precipitation Acidity in the Central Sierra Nevada.	Gross Losses and Their Variability. W91-11345 2D
Impact of Physico-chemical Complexes on	W91-10471 5B	Rainfall Interception by Trees of Pinus radiata
Plankton Density in Dhir Beel of Assam.	Analysis of Precipitation Chemistry Measure-	and Eucalyptus viminalis in a 1300 mm Rainfall
W91-11527 2H	ments in Shimane, Japan. W91-10472 2B	Area of Southeastern New South Wales: II. In- fluence of Wind-Borne Precipitation.
POPULATION DYNAMICS		W91-11346 2D
Bloom of Coscinodiscus wailesii and DO Deficit	Impact of Changing Regional Emissions on Pre- cipitation Chemistry in the Eastern United	
of Bottom Water in Seto Inland Sea. W91-10549 5C	States. W91-10473 5G	Spring and Summer 1988 Drought over the Contiguous United States-Causes and Predic-
Dispersal Dynamics of Groundwater Bacteria.	W91-104/3	tion. W91-11412 2B
W91-10843 5B	Relationship Between Mean and Standard Devi- ation in Precipitation Chemistry Measurements	Spatial Distribution of Precipitation Seasonality
Mercury Body Burden and Otolith Characteris-	Across Eastern North America.	in the United States.
tics of Bluefin Tuna from the Northwest Medi- terranean (Balearic Sea).	W91-10475 2B	W91-11414 2B
W91-10881 2L	Dry Deposition Washoff from Forest Tree Leaves by Experimental Acid Rainfall.	Convective Cell in a Hurricane Rainband. W91-11422 2B
POPULATION EXPOSURE	W91-10476 5B	
Fertility of Workers Chronically Exposed to Chemically Contaminated Sewer Wastes.	Research on Clouds and Precipitation: Past,	Dynamical Forcing and Mesoscale Organization of Precipitation Bands in a Midwest Winter Cy-
W91-11316 5D	Present and Future, Part II. W91-10481 3B	clonic Storm. W91-11424 2E
PORE PRESSURE		
Electroosmotic Strengthening of Soft Sensitive	Estimating the Effects on the Regional Precipi- tation Climate in a Semiarid Region Caused by	PRECIPITATION INTENSITY  Numerical Simulations of the Evolution of a
Clays.	an Artificial Lake Using a Mesoscale Model.	Cold Front and its Precipitation.
W91-10777 8D	W91-10502 2B	W91-11418 2E
PORE SIZE	Electrical and Kinematic Structure of the Strati-	Squall Line in Southern Germany: Kinematics
Change in Pore Size Distribution Owing to Sec- ondary Consolidation of Clays.	form Precipitation Region Trailing an Oklahoma Squall Line.	and Precipitation Formation as Deduced by Ad- vanced Polarimetric and Doppler Radar Meas
W91-10774 8D	W91-10514 2B	urements.
POROUS MEDIA	Three-Dimensional Simulation of Airflow and	W91-11420 2E
Application of a Multiprocess Nonequilibrium Sorption Model to Solute Transport in a Strati-	Orographic Rain Over the Island of Hawaii.	PRECIPITATION MAPPING
fied Porous Medium.	W91-10317	Precipitation Changes in Fall, Winter, and Spring Caused by St Louis.
W91-11239 5B	Meteorology and Oceanography in the Seto Inland Sea.	W91-10500 2I
Diffusion in Fractal Porous Media. W91-11243 2F	W91-10520 2L	Estimating the Effects on the Regional Precipi
	Hydrological Aspects of the 1988 Drought in	tation Climate in a Semiarid Region Caused by an Artificial Lake Using a Mesoscale Model
New Approach to Tracer Transport Analysis: From Fracture Systems to Strongly Heterogene-	Attitioss:	W91-10502 21
ous Porous Media.		Spatial Distribution of Rainfall in the Greate
W91-11554 2F		Athens Area.
PORTUGAL	Maximum Hailstone Size. W91-10858 2B	W91-11416 21
Contribution for the Study of New Pathogenic		Numerical Simulations of the Evolution of
Indicators Removal from W. S. P. in Portugal. W91-10689 5D	Microclimatological Investigations in the Tropi-	Cold Front and its Precipitation. W91-11418 21
	a Drought-Induced Alpine Timberline.	
POTABLE WATER	W91-10878 2I	Squall Line in Southern Germany: Kinematic and Precipitation Formation as Deduced by Ad
Use of a Backflush Technique in Cross-flow Microfiltration for Treating Natural Water and		vanced Polarimetric and Doppler Radar Mean
Filter Backwash Wastewater in Water Works	ductance in Relation to Tree Spacing.	urements.
W01 11270 SF	W91-10905 2I	W91-11420 21

# PRECIPITATION MAPPING

Sensitivity Studies of Tropical Storm Genesis Using a Numerical Model.	Eastern Mediterranean: A Marine Desert. W91-10553 2H	Use of Risk Assessment for Development of Microbial Standards.
W91-11421 2B		W91-10619 5G
Assessment of VAS-Derived Retrievals and Pa-	Macrophyte Standing Crop and Primary Pro- ductivity in Some Florida Spring-Runs.	Epidemiology of Human Cryptosporidiosis and
rameters used in Thunderstorm Forecasting. W91-11423 2B	W91-10812 2E	the Water Route of Infection. W91-10643 5B
	Primary Productivity and Plankton Communi-	W 91-10043 3D
Dynamical Forcing and Mesoscale Organization of Precipitation Bands in a Midwest Winter Cy-	ties in a Two-Reservoir Series. W91-10815 2H	Isolation and Identification of Cryptosporidium from Water.
clonic Storm.		W91-10644 5A
W91-11424 2B	Potential Effects of Global Warming on the	
DEPOSITE OF PARTY OF	Primary Productivity of a Subalpine Lake.	Occurrence of Cryptosporidium spp. Oocysts in
PRECIPITATION RATE	W91-10819 2H	Scottish Waters, and the Development of a
Comparison of Microwave Techniques for	Z1-i	Fluorogenic Viability Assay for Individual
Measuring Rainfall. W91-10499 2B	Zooplankton Effects on Phytoplankton in Lakes	Cryptosporidium Oocysts.
W91-10499 2B	of Contrasting Trophic Status.	W91-10645 5B
PRECIPITATION SCAVENGING	W91-10859 2H	Determining Giardiania Bernaleura hu Francisco
Efficiency With Which Drizzle and Precipita-	Coulometric Measurement of Primary Produc-	Determining Giardiasis Prevalence by Examina- tion of Sewage.
tion Sized Drops Collide With Aerosol Particles.	tion, with Comparison against Dissolved	W91-10646 5A
W91-11252 2B	Oxygen and 14-C Methods in a Seasonal Study.	W91-10040 3A
	W91-10868 2L	Occurrence and Viability of Giardia spp. Cysts
Aerosol and Hydrometeor Concentrations and		in UK Waters.
Their Chemical Composition During Winter	PRIORITY POLLUTANTS	W91-10647 5B
Precipitation Along a Mountain Slope: III. Size-	Quantitative Determination of Acrylonitrile in	
Differentiated In-Cloud Scavenging Efficiencies.	an Industrial Effluent by Ambient-Temperature	Wastewater and Giardia Cysts.
W91-11253 2B	Purge and Trap Capillary GC-MS and by	W91-10648 5B
PRECONCENTRATION	Heated Purge and Trap GC-FID.	
Rapid Preconcentration Method for Multiele-	W91-11336 5A	Distribution of Giardia Cysts in Wastewater.
ment Analysis of Natural Freshwaters.		W91-10649 5B
W91-10892 7B	PROBABILITY DISTRIBUTION	Analysis of Cubford Challed Destages in the
117110072	Maximum Entropy View of Probability-Distrib-	Analysis of Subfossil Shelled Protozoa in the Sediments of a Small Acid Forest Lake (Kleiner
Determination of Trace Levels of Sulphate in	uted Catchment Models.	
Water Using Flow-Injection and In-Line Pre-	W91-10965 2A	Barsch-See, Northern GDR) (Analyse Subfos- siler Protozoenschalen der Sedimente eines
concentration.	PROBABLE MAXIMUM PRECIPITATION	Kleinen Sauren Waldsees) (Kleiner Barsch-See,
W91-11246 2K	Estimation of the Mean Field Bias of Radar	Nordliche DDR).
D	Rainfall Estimates.	W91-11516 2H
Preconcentration of Hydrophilic and Hydropho-	W91-10857 2B	W91-11310 211
bic Pesticides from Aqueous Solutions and Ex-	W/1-1003/	PROVINCIAL JURISDICTION
traction of Residues Using the Polymeric Sor- bent Wofatit Y 77.	PROCESS CONTROL	Provincial Guidelines to Great Lakes Shoreline
W91-11305 5A	Conductivity for Nutrient Control In CTMP	Management Plans.
W91-11303	Wastewater Treatment.	W91-11024 6E
PREDATION	W91-11495 5D	
Bdellovibrio sp.: A Predator under Groundwat-		Interprovincial Water Management in Western
er Conditions. A Short Communication.	PROCESS PONDS	Canada.
W91-10676 5B	Status Report on Remedial Investigation of the	W91-11040 6E
	300 Area Process Ponds.	PSEUDOKARST
PRESSURE FILTRATION	W91-11583 5G	Piping and Pseudokarst in Drylands.
Comparison of Pressurized and Gravity Distri-	PRODUCTIVITY	W91-11561 2F
bution Systems for Wastewater Treatment.	Economic Analysis of Soil Conservation Tech-	W 91-11301 21
W91-10845 5D	nologies.	PSEUDOMONAS
PRETREATMENT OF WASTEWATER	W91-11566 4D	Relationship Between Pseudomonas aeruginosi
Anaerobic Treatability of a Phenolic Coal Con-	117111300	and Bacterial Indicators in Polluted Natura
version Wastewater After Diisopropyl Ether	PROFESSIONAL PERSONNEL	Waters.
Extraction.	Assessing Stream Values: Perspectives of Aquat-	W91-10635 5.A
W91-10939 5D	ic Resource Professionals.	
	W91-11425 8I	PUBLIC ACCESS
PRICING	****	Providing Access for the Public to the Shoreline
Costs and Benefits of Moving to Peak-Load	PROJECT PLANNING	of San Francisco Bay.
Pricing for Municipally-Supplied Water.	Red River Basin Grass Roots Policy Process.	W91-10589 6E
W91-11047 6C	W91-11185 6B	PUBLIC HEALTH
Industrial Water Pricing for Ontario: Towards	First Steps Toward Increasing the Reliability of	Lessons Learned from a Third World Water and
Realistic Pricing.	Hydropower and Water-Management Facilities.	Sanitation Project.
W91-11048 6C	W91-11291 8A	W91-10503 51
1171-110-10		W 71-10303
Implications of Full-Cost Recovery Water Rates	Socio-Economic Impact of Improved Wells in	Health-Related Water Microbiology 1990.
on Irrigated Farms in Saskatchewan.	Rural Sierra Leone.	W91-10612 51
W91-11054 6C	W91-11358 6B	
DEDICATE DE DESCRIPTION	Francis Co. March. Mr. 1.	Causes of Waterborne Outbreaks in the United
PRIMARY PRODUCTIVITY	Framework for Planning, Monitoring, and Eval-	States.
Seasonal Variation of Biomass and Production	uating Watershed Conservation Projects.	W91-10616 51
Dynamics for Above and Belowground Compo-	W91-11570 6B	Thomas Water's Panarianan with Carry
nents of a Spartina alterniflora Marsh in the	PROTEINS	Thames Water's Experiences with Cryptosport
Euhaline Sector of Paranagua Bay (SE Brazil).	Effects of Copper and Tributyltin on Stress Pro-	dium.
W91-10495 2L	tein Abundance in the Rotifer Brachionus plica-	W91-10617 56
Evaluation of Primary Production Loads and	tilis.	Prospective Epidemiological Study of Drinkin
Their Control in Enclosed Seas.	W91-10900 5C	Water Related Gastrointestinal Illnesses.
W91-10524 5G		W91-10618 5
30	PROTOZOA	
Numerical Simulation of Water Quality in	Thames Water's Experiences with Cryptospori-	Use of Risk Assessment for Development of
Tokyo Bay.	dium.	Microbial Standards.
W01.10528 5D	W01 10617	W01 10610

Public Health Criteria for the Aquatic Environ- ment: Recent WHO Guidelines and Their Appli- cation.	herence from Iowa and Virginia Farmer's Atti- tudes. W91-11437 5G	Trends In Water Pollution Control In the Finnish Pulp and Paper Industry. W91-11468 5G
W91-10620 5G Need for New Microbiological Water Quality	PUBLIC PARTICIPATION  Environmental Activism in the San Francisco	Trends in Pollution Control In the Swedish Pulp
Criteria. W91-10621 5F	Bay Estuary. W91-10585 5G	and Paper Industry. W91-11469 5G
EC Bathing Water Virological Standard: Is It Realistic. W91-10622 5A	Citizen's Movements to Protect the Environ- ment of Rivers Flowing into the Seto Inland	Regulatory Requirements for Pulp and Paper Mill Effluent Control: Scientific Basis and Con- sequences.
Production and Control of Reference Materials	Sea: An Example of a Citizen's Movement Along the Toga River. W91-10587 5G	W91-11470 5G
for Water Microbiology. W91-10623 5A	Nongovernmental Educational Activities for	Goals, Regulations and Information Needs for Wastewater Discharge Management-An Ameri- can Perspective.
Surveillance Solutions to Microbiological Prob- lems in Water Quality Control in Developing	Environmental Protection. W91-10588 5G	W91-11471 5G
Countries. W91-10625 5G	National Estuary Program and Public Involve- ment.	Process Internal Measures to Reduce Pulp Mill Pollution Load.
Isolation and Identification of Cryptosporidium from Water.	W91-10590 5G	W91-11473 5G Effects of Chlorination Conditions On the AOX
W91-10644 5A	Water Control Systems and the Traditional Fes- tival at Miyawaki, on the Seto Inland Sea. W91-10591 3F	and Chlorinated Phenol Content of Kraft Bleach Plant Wastewaters.
Determining Giardiasis Prevalence by Examina- tion of Sewage.	What Stakeholders Want and Why.	W91-11474 5D
W91-10646 5A	W91-11035 6A	Identification of Dioxin Sources In an Integrated Wood Processing Facility.
Wastewater and Giardia Cysts. W91-10648 5B	Strategies for Nonprofit Organizations for Pre- venting Agrichemical Contamination of Ground	W91-11475 5B
Distribution of Giardia Cysts in Wastewater. W91-10649 5B	Water. W91-11204 5G	Biological Bleaching of Wood Pulps—A Viable Chlorine-Free Bleaching Technology.
Review of the Epidemiology and Diagnosis of	In the Land of the Giants: Grassroots Organiz- ing in California's Central Valley.	W91-11476 5G
Waterborne Viral Infections. W91-10651 5B	W91-11205 5G	Closing Paper Mill Whitewater Circuits by In- serting an Anaerobic Stage with Subsequent Treatment.
Detection of Hepatitis A Virus and Other Enter- oviruses in Wastewater and Surface Water Sam- ples by Gene Probe Assay.	Waste Disposal Facilities and Community Re- sponse: Tracing Pathways from Facility Impacts to Community Attitude.	W91-11477 3G Future Perspectives for the Anaerobic Treat-
W91-10665 5A	W91-11280 5E	ment of Forest Industry Wastewaters.
Disinfection Capability in Water for Swimming and Bathing Pools: A Simple Method for Their Evaluation in Practice.	First Steps Toward Increasing the Reliability of Hydropower and Water-Management Facilities. W91-11291 8A	W91-11478 5D  Anaerobic Toxicity of Fines In Chemi-thermo- mechanical Pulp Wastewaters: A Batch Assay-
W91-10684 5F Health Risk Assessment of Toluene in California	PUBLIC POLICY  Do We Have a National Water Policy.	Reactor Study Comparison. W91-11479 5D
Drinking Water. W91-10741 5C	W91-10505 6B	Anaerobic Biodegradability and Methanogenic
Drinking Water Criteria Document on Xylene.	Legal System and Management of Southern France Lagoons.	Toxicity of Pulping Wastewaters. W91-11480 5D
W91-10757 5C	W91-10611 5G	Treatment and Detoxification of Aqueous
Pulsed Field Electrophoresis of Genomic Re- striction Fragments for the Detection of Noso- comial Legionella pneumophila in Hospital	Watershed Years at Niagara Falls: Canadian and American Policy Responses to New Meanings of Power, 1905-1914.	Spruce Bark Extracts by Aspergillus niger. W91-11481 5D
Water Supplies. W91-10836 5A	W91-11038 6E  Red River Basin Grass Roots Policy Process.	Effect of NSSC Spent Liquor on Granule For- mation and Specific Microbial Activities In
Water and Human Health.	W91-11185 6B	Upflow Anaerobic Reactors. W91-11482 5D
W91-11211 5F Situation of Water Supply in the New Lander of	Legislative Implementation of Integrated Catch- ment Management in Western Australia.	Thermophilic Anaerobic Treatment of Sulfate Rich Pulp and Paper Integrate Process Water.
the Federal Republic of Germany. W91-11272 5F	W91-11374 6E	W91-11483 5D
Fertility of Workers Chronically Exposed to	PUBLIC WATERS  Wellhead Protection in Massachusetts: Protecting Public Water Supplies from Pesticide Im-	Practical Experience with Biological Removal of Phosphorus from Pulp and Paper Mill Ef-
Chemically Contaminated Sewer Wastes. W91-11316 5D	pacts. W91-11182 5G	fluents. W91-11496 5D
Results of the First Pilot-Scale Controlled Cohort Epidemiological Investigation into the	PUGET SOUND	Biotechnological Sulphide Removal from Ef
Possible Health Effects of Bathing in Seawater at Langland Bay, Swansea.	Strategies for Restoring and Developing Fish Habitats in the Strait of Georgia: Puget Sound	fluents. W91-11502 5E
W91-11366 5C	Inland Sea, Northeast Pacific Ocean. W91-10568 5G	Monitoring of Organochlorine Compounds Is Finnish Inland Waters Polluted by Pulp and
PUBLIC OPINION  Waste Disposal Facilities and Community Response: Tracing Pathways from Facility Impacts	Environmental Management of the Puget Sound.	Paper Effluents Using the Mussel Incubation Method.
to Community Attitude.  W91-11280  5E	W91-10577 5G	W91-11507 5A
Ground Water Contamination from Agricultural	PULP AND PAPER INDUSTRY Forest Industry Wastewaters. W91-11467 5D	Eutrophication of Pulp and Paper Wastewate Recipients. W91-11509 50
Sources: Implications for Voluntary Policy Ad-	W91-11467 5D	1173-11907

# PULP WASTES

ULP WASTES	Treatment of Bleaching Effluents In Aerobic/	Eutrophication of Pulp and Paper Wastewater
Control of Enteric Micro-organisms by Aerobic- Thermophilic Co-Composting of Wastewater	Anaerobic Fluidized Biofilm Systems. W91-11486 5D	Recipients. W91-11509 5C
Sludge and Agro-Industry Sludge. W91-10693 5E	Onset of Lignin-Modifying Enzymes, Decrease of AOX and Color Removal by White-Rot	Nitrogen Dynamics of Pulp and Paper Sludge
Dioxin Contamination and Growth and Devel-	Fungi Grown on Bleach Plant Effluents.	Amendment to Forest Soils. W91-11510 5E
opment in Great Blue Heron Embryos. W91-10837 5C	W91-11487 5D  Decrease of Pollutant Level of Bleaching Ef-	Activated Sludge Treatment of Kraft Mill Ef-
Removal of Acetate from NSSC Sulphite Pulp	fluents and Winning Valuable Products by Suc-	fluents from Conventional and Oxygen Bleach- ing.
Mill Condensates Using Thermophilic Bacteria. W91-10889 5D	cessive Flocculation and Microbial Growth. W91-11488 5D	W91-11511 5D
	Treatment of Bleach-Plant Effluents with Mem-	PUMP WELLS
Effect of a Chelating Agent (DTPA) on Anaero- bic Wastewater Treatment in an Upflow Sludge Blanket Filter.	brane Filtration and Sorption Techniques. W91-11489 5D	Analytical Modeling of Aquifer Decontamina- tion by Pumping When Transport is Affected by Rate-Limited Sorption.
W91-11277 5D	Membrane Filtration Combined with Biological	W91-11235 5G
Forest Industry Wastewaters.	Treatment for Purification of Bleach Plant Ef- fluents.	PUMPING PLANTS
W91-11467 5D	W91-11490 5D	St. Johns Bayou Pumping Station, Missouri: Hy-
Trends In Water Pollution Control In the Finn-	Treatment of Pulp-Bleaching Effluents by Acti-	draulic Model Investigation. W91-11588 8C
ish Pulp and Paper Industry. W91-11468 5G	vated Sludge, Precipitation, Ozonation and Irra-	
	diation. W91-11491 5D	PUMPING STATIONS St. Johns Bayou Pumping Station, Missouri: Hy-
Trends in Pollution Control In the Swedish Pulp and Paper Industry.	W91-11491 5D	draulic Model Investigation.
W91-11469 5G	Criteria for Nutrient-Balanced Operation of Ac- tivated Sludge Process.	W91-11588 8C
Regulatory Requirements for Pulp and Paper	W91-11493 5D	PUMPING TESTS
Mill Effluent Control: Scientific Basis and Con-	Nitrogen and Phosphorus Limits for Nutrient	Delineation of Traveltime-Related Capture
sequences. W91-11470 5G	Deficient Industrial Wastewaters. W91-11494 5D	Areas of Wells Using Analytical Flow Models and Particle-Tracking Analysis.
Goals, Regulations and Information Needs for		W91-10957 2F
Wastewater Discharge Management-An Ameri-	Conductivity for Nutrient Control In CTMP Wastewater Treatment.	Method to Determine the Formation Constants
can Perspective. W91-11471 5G	W91-11495 5D	of Leaky Aquifers, and Its Application to Pump- ing Test Data.
	Practical Experience with Biological Removal	W91-10961 7C
Process Internal Measures to Reduce Pulp Mill Pollution Load.	of Phosphorus from Pulp and Paper Mill Ef- fluents.	Discrete-Kernel Method for Simulating Pump-
W91-11473 5G	W91-11496 5D	ing Tests in Large-Diameter Wells. W91-10998 2F
Effects of Chlorination Conditions On the AOX	Biological Dehalogenation of Kraft Mill	W91-10996 2F
and Chlorinated Phenol Content of Kraft Bleach Plant Wastewaters.	Wastewaters.	Evaluation of Analytical Solutions to Estimate
W91-11474 5D	W91-11497 5D	Drawdowns and Stream Depletions by Wells. W91-11240 2F
Identification of Dioxin Sources In an Integrated	Factors Affecting the Removal and Discharge	
Wood Processing Facility.	of Organic Chlorine Compounds at Activated Sludge Treatment Plants.	Graphical Method for Determining the Coeffi- cient of Consolidation cv from a Fiow-Pump
W91-11475 5B	W91-11498 5D	Permeability Test.
Closing Paper Mill Whitewater Circuits by In-	Treatability of Bleached Kraft Pulp and Paper	W91-11393 7C
serting an Anaerobic Stage with Subsequent	Mill Wastewaters In a New Zealand Aerated	PUMPS
Treatment. W91-11477 5G	Lagoon Treatment System. W91-11499 5D	Graphical Method for Determining the Coeffi- cient of Consolidation cv from a Flow-Pump
Future Perspectives for the Anaerobic Treat-	Treatment Technologies for Organochlorine-	Permeability Test. W91-11393 7C
ment of Forest Industry Wastewaters.	Containing Sludges and Concentrates from Ex-	W91-11393 7C
W91-11478 5D	ternal Treatment of Pulp and Paper Wastewaters.	QUALITY ASSURANCE
Anaerobic Toxicity of Fines In Chemi-thermo- mechanical Pulp Wastewaters: A Batch Assay-	W91-11500 5D	Surveillance Solutions to Microbiological Prob- lems in Water Quality Control in Developing
Reactor Study Comparison.	Anaerobic Treatment of Bleached TMP and	Countries. W91-10625 5G
W91-11479 5D	CTMP Effluent In the BioPAQ UASB System.	
Anaerobic Biodegradability and Methanogenic	W91-11501 5D	QUALITY CONTROL
Toxicity of Pulping Wastewaters.	Thermocatalytic and Chemical Treatment of	Production and Control of Reference Materials for Water Microbiology.
W91-11480 5D	Lignin-Aluminium Sludge and Utilization of the Resulting Adsorbent-Coagulant.	W91-10623 5A
Effect of NSSC Spent Liquor on Granule For-	W91-11503 5D	Preliminary Statistical Assessment of UK Water
mation and Specific Microbial Activities In	Environmentally Desirable Approaches for Reg-	Quality Control Trials.
Upflow Anaerobic Reactors. W91-11482 5D	ulating Effluents from Pulp Mills.	W91-10624 5G
Thermophilic Anaerobic Treatment of Sulfate-	W91-11504 5G	QUANTITATIVE ANALYSIS
Rich Pulp and Paper Integrate Process Water.	Monitoring of Organochlorine Compounds In	Quantitative Determination of Acrylonitrile in
W91-11483 5D	Finnish Inland Waters Polluted by Pulp and Paper Effluents Using the Mussel Incubation	an Industrial Effluent by Ambient-Temperature Purge and Trap Capillary GC-MS and by
Biodegradability of Chlorinated Organic Com-	Method.	Heated Purge and Trap GC-FID.
pounds In Pulp Bleaching Effluents. W91-11484 5D	W91-11507 5A	W91-11336 5A
	Formation of Chlorophenols and Related Com-	QUEBEC
Oxic Fluidized-Bed Treatment of Dichlorophen- ols.	pounds In Natural and Technical Chlorination Processes.	Modification of Benthic Community Structure in Response to Acid-Iron Wastes Discharge.
W91-11485 5D	W91-11508 5B	W91-10869 5C

Subice Layering and Origin of Acidic Waters in a Small Boreal Lake During the Spring Runoff. W91-11229 5B	Measuring Low Radon Levels in Drinking Water Supplies. W91-11463 5A	Electrical and Kinematic Structure of the Strati- form Precipitation Region Trailing an Oklahoma Squall Line.
		W91-10514 2B
RADAR	RADIOISOTOPES	
Analysis of Ground-Probing Radar Data: Pre- dictive Deconvolution.	Geochemical Evolution in the Cambrian-Ordo- vician Sandstone Aquifer, Eastern Wisconsin: 1.	Case Studies in Data Analysis. W91-10733 2B
W91-10782 8G	Major Ion and Radionuclide Distribution.	W 31-10/33
Estimation of the Man Bield Bies of Rades	W91-10953 2K	Estimation of the Mean Field Bias of Radar
Estimation of the Mean Field Bias of Radar Rainfall Estimates.	Embedding and Response Matrix Techniques for	Rainfall Estimates. W91-10857 2B
W91-10857 2B	Maximizing Steady-State Ground-Water Extrac- tion; Computational Comparison.	
Use of Single-Doppler Radar for Estimating	W91-10954 2F	Rainfall Interception by Trees of Pinus radiata
Maximum Hailstone Size.	and December 2011 - 11 - 11 - 11 - 11 - 11 - 11 - 11	and Eucalyptus viminalis in a 1300 mm Rainfall Area of Southeastern New South Wales: I.
W91-10858 2B	226-Ra and Other Radionuclides in Water, Vegetation, and Tissues of Beavers (Castor cana-	Gross Losses and Their Variability.
Application of Ground-Penetrating-Radar Meth-	densis) from a Watershed Containing U Tailings	W91-11345 2D
ods in Hydrogeologic Studies.	Near Elliot Lake, Canada.	Rainfall Interception by Trees of Pinus radiata
W91-10956 7B	W91-11454 5B	and Eucalyptus viminalis in a 1300 mm Rainfall
Multiparameter Radar Estimation of Raindrop	RADIOMETRY	Area of Southeastern New South Wales: II. In-
Size Distribution.	NOAA Satellite Data in Natural Oil Slick De-	fluence of Wind-Borne Precipitation.
W91-11097 7B	tection, Otway Basin, Southern Australia.	W91-11346 2D
Empirical Method of Estimating Raingage and	W91-11296 5A	Empirical Method of Estimating Raingage and
Radar Rainfall Measurement Bias and Resolu-	RADIOSONDES	Radar Rainfall Measurement Bias and Resolu-
tion.	Assessment of VAS-Derived Retrievals and Pa-	tion.
W91-11409 2B	rameters used in Thunderstorm Forecasting. W91-11423 2B	W91-11409 2B
Squall Line in Southern Germany: Kinematics	W91-11423 25	RAINFALL DISTRIBUTION
and Precipitation Formation as Deduced by Ad-	RADIUM RADIOISOTOPES	Three-Dimensional Simulation of Airflow and
vanced Polarimetric and Doppler Radar Meas-	226-Ra and Other Radionuclides in Water,	Orographic Rain Over the Island of Hawaii.
urements. W91-11420 2B	Vegetation, and Tissues of Beavers (Castor cana- densis) from a Watershed Containing U Tailings	W91-10517 2B
W91-11420 2B	Near Elliot Lake, Canada.	Four-Parameter Model for the Estimation of
Convective Cell in a Hurricane Rainband.	W91-11454 5B	Rainfall Frequency in South-West England.
W91-11422 2B	RADON	W91-11415 2B
RADIATION	Characterization of Radioactivity in Hot Springs	
Microcystis Changes its Buoyancy in Response	National Park, Arkansas.	Spatial Distribution of Rainfall in the Greater
to the Average Irradiance in the Surface Mixed	W91-10846 2K	Athens Area. W91-11416 2B
Layer. W91-10895 2H	Evaluating Aeration Technology for Radon Re-	W71-11410
W 91-10093	moval.	RAINFALL FORECASTING
RADIOACTIVE DATING	W91-11462 5F	Dynamic Simulation Model of Vertical Infiltra-
Evidence for Dilution of Deep, Confined		tion of Water in Soil. W91-10968 2A
Ground Water by Vertical Recharge of Isotopi- cally Heavy Pleistocene Water.	Water Supplies.	W 21-10300
W91-10792 2F	W91-11463 5A	RAINFALL INTENSITY
D O. N	Radon in Homes Following Its Reduction in a	Four-Parameter Model for the Estimation of Rainfall Frequency in South-West England.
Recent Sedimentation in Lake Michigan. W91-10976 2J	Community Water Supply.	W91-11415 2B
***************************************	W91-11464 5B	W71-11415
RADIOACTIVE SPRINGS	RAIN	RAINFALL RATE
Characterization of Radioactivity in Hot Springs National Park, Arkansas.	Laboratory Measurements of Sman Ramurop	Comparison of Microwave Techniques for
W91-10846 2K	Distortion. Part I: Axis Ratios and Fall Behav-	Measuring Rainfall. W91-10499 2E
	ior. W91-10513 2B	
RADIOACTIVE WASTE DISPOSAL Hydrogeologic Inferences from Drillers' Logs		Precipitation Changes in Fall, Winter, and
and from Gravity and Resistivity Surveys in the		Spring Caused by St Louis. W91-10500 2E
Amargosa Desert, Southern Nevada.	W91-11097 7B	W91-10300
W91-10996 5E		Four-Parameter Model for the Estimation of
Dendrogeomorphic Approach to Estimating	RAIN FORESTS	Rainfall Frequency in South-West England.
Slope Retreat, Maxey Flats, Kentucky.	Rainwater and Throughfall Chemistry in a "Terre Firme' Rain Forest: Central Amazonia.	W91-11415 2E
W91-11395 2D	W91-11218 2B	RAINFALL-RUNOFF RELATIONSHIPS
RADIOACTIVE WASTES	PATRICACES	Hydrological Aspects of the 1988 Drought in
Environmental Problems and Solutions: Green	RAIN GAGES  Empirical Method of Estimating Raingage and	Illinois.
house Effect, Acid Rain, Pollution.	Radar Rainfall Measurement Bias and Resolu-	W91-10810 2E
W91-11066 5E	1011	Hydrological Balance of Two Mediterraneau
RADIOACTIVITY	W91-11409 2B	Forested Catchments (Prades, Northeast Spain)
Radioactivity in Water Treatment Wastes: A		W91-10963 2A
USEPA Perspective.	Rainfall Frequency in South-West England.	Maximum Entropy View of Probability-Distrib
W91-11461 5I	W91-11415 2B	uted Catchment Models.
RADIOCHEMICAL ANALYSIS	RAINFALL	W91-10965 2A
Transformation of (C-14)-2,4-Dichlorophenol in		Runoff Analysis of the Chang Jiang (Th
Saskatchewan Soils. W91-10922 51	Spring Caused by St Louis. W91-10500 2B	17 . W
W91-10922 51		W91-10966 21
New Standards for the Determination of Geos		Dynamic-Stochastic Models of Rainfall and
min and Methylisoborneol in Water by Ga Chromatography/Mass Spectroscopy.	Distortion. Part I: Axis Ratios and Fall Behavior.	Snowmelt Runoff Formation.
W91-11329 5A		W91-10967 24

### RAINFALL-RUNOFF RELATIONSHIPS

Dynamic Simulation Model of Vertical Infiltra- tion of Water in Soil.	Evaluating the Impact of Water Quality Upon the Value of Recreational Fishing.	1987-89 Drop in Great Lakes Water Levels, Causes and Effect.
W91-10968 2A	W91-11058 6G	W91-11023 2H
Throughflow and Solute Transport in an Isolat-	RED RIVER	Regulation of Lake Ontario Levels.
ed Sloping Soil Block in a Forested Catchment. W91-10993	Upstream Extirpation of Four Minnow Species Due to Damming of a Prairie Stream.	W91-11028 6A
Comparison of Mean Annual Runoff Estimates	W91-11535 6G	Managing Water Resources in Latin America.
in the Canadian Portion of the Great Lakes	RED RIVER BASIN	W91-11385 6B
Basin.	Red River Basin Grass Roots Policy Process.	REGULATIONS
W91-11020 2E	W91-11185 6B	Environmental Research, Policy and Regula-
Geomorphological Dispersion.	RED SEA	tion: The Chesapeake Bay Experience.
W91-11232 2E	Egyptian Approach Towards Appropriate Use	W91-10575 5G
Streamflow Generation in a Headwater Basin on	of Coastal Zones on the Red Sea.	Non-Regulatory Approaches to Management of
the Precambrian Shield.	W91-10561 6G	Coastal Resources and Development in San
W91-11349 2E	RED TIDE	Francisco Bay.
Point-Infiltration Model for Estimating Runoff	Life Cycle Strategies of the Red Tide Causing	W91-10576 2L
from Rainfall on Small Basins in Semiarid Areas	Flagellates Chattonella (Raphidophyceae) in the	Legal System and Management of Southern
of Wyoming.	Seto Inland Sea.	France Lagoons.
W91-11585 2E	W91-10546 5B	W91-10611 5G
Characterization and Simulation of Rainfall-	Growth Potentials of Red Tide Phytoplankters	Provincial Guidelines to Great Labor Shareline
Runoff Relations for Headwater Basins in West-	in Coastal Seawater by AGP Assay.	Provincial Guidelines to Great Lakes Shoreline Management Plans.
ern King and Snohomish Counties, Washington. W91-11592 2A	W91-10548 5A	W91-11024 6E
	Personal Computer System Supporting Water	
AINSTORMS	Quality Management in Eutrophicated Bay.	Sludge Recycling in Agriculture Compared with
Estimation of the Mean Field Bias of Radar Rainfall Estimates.	W91-10582 5G	Other Disposal Methods in France.
W91-10857 2B	REFLECTANCE	W91-11137 5E
	Satellite-Derived Reflectance of Snow-Covered	Returnable Pesticide Containers: Maine's Depos-
Use of Single-Doppler Radar for Estimating Maximum Hailstone Size.	Surfaces in Northern Minnesota.	it and Collection System.
W91-10858 2B	W91-11353 7C	W91-11191 5G
	REFLECTANCE TECHNIQUES	Oregon Pesticide Container Initiative.
Superfund Record of Decision: Kin-Buc Land-	Satellite-Derived Reflectance of Snow-Covered	W91-11192 5E
fill, NJ.	Surfaces in Northern Minnesota.	
W91-10755 5G	W91-11353 7C	Legislative Implementation of Integrated Catch-
RECEIVING WATERS	REGENERATION	ment Management in Western Australia. W91-11374 6E
Bacterial Water Quality in Urban Receiving	Evaluation of Full Scale Activated Sludge Sys-	W 21-113/4
Waters.	tems Utilizing Powdered Activated Carbon Ad-	Goals, Regulations and Information Needs for
W91-10633 5B	dition with Wet Air Regeneration.	Wastewater Discharge ManagementAn Ameri-
RECESSION CURVE	W91-11099 5D	can Perspective. W91-11471 5G
Contribution to the Study of the Recession	REGIONAL ANALYSIS	W71-114/1 3G
Curves of Karstic Springs: Examples from	Method of Compiling Water-Management Bal-	Environmentally Desirable Approaches for Reg-
Greece (Contribution a l'Etude des Courses de Recession des Sources Karstiques: Exemples du	ances.	ulating Effluents from Pulp Mills.
Pays Hellenique).	W91-11293 2A	W91-11504 5G
W91-10990 2F	Spatial Distribution of Precipitation Seasonality	New Storm Water Regulations Require Signifi-
RECHARGE	in the United States.	cant Compliance Actions by Both Industries and
Potential for Aquifer Recharge in Illinois (Ap-	W91-11414 2B	Municipalities.
propriate Recharge Areas).	REGIONAL AQUIFER SYSTEM ANALYSIS	W91-11541 5D
W91-11580 7C	Hydrogeology of the Point Lookout Sandstone	Toxicity Reduction Evaluations (TRE's) As a
RECIRCULATED WATER	in the San Juan Structural Basin, New Mexico,	Tool for Meeting Effluent Standards.
Design and Performance of the BIOFISH Water	Colorado, Arizona, and Utah. W91-11114 2F	W91-11542 6E
Recirculation System.	W91-11114 2F	REHABILITATION
W91-11548 5D	REGIONAL AQUIFER SYSTEMS ANALYSIS	Future Water Management Problems: The Fed-
RECKNITZ RIVER	Geologic Framework of the Columbia Plateau	eral Role In Their Solution.
Saprobiological Investigations on the Bottom	Aquifer System, Washington, Oregon, and Idaho.	W91-11210 4A
Flora of the River Recknitz in the Northern Part of the Mecklenburgian Lake District (GDR)	W91-11571 2F	Optimal Data Acquisition Strategy for the De-
(Saprobiologische Untersuchungen an der		velopment of a Transport Model for Ground-
Benthosflora der Recknitz im Norden der Meck-	REGIONAL DEVELOPMENT	water Remediation.
lenburger Seenplatte (DDR)).	Managing Water Resources in Latin America. W91-11385 6B	W91-11238 5G
W91-11520 2E		Revegetation Technologies
RECREATION	REGULATED FLOW	Revegetation Technologies. W91-11568 4D
EC Bathing Water Virological Standard: Is It	Macroinvertebrate Responses along a Complex Regulated Stream Environmental Gradient.	
Realistic. W91-10622 5A	W91-10848 4A	RELIABILITY
		First Steps Toward Increasing the Reliability of
Virological Quality of Recreational Waters in	Rhine Rift Valley Groundwater-River Interac-	Hydropower and Water-Management Facilities. W91-11291 8A
the Netherlands. W91-10653 5B	tions: Evolution of their Susceptibility to Pollu- tion.	177-11471 8A
	W91-10849 5B	REMEDIAL ACTION PLANS
Disinfection Capability in Water for Swimming		Successes and Challenges in Developing and
and Bathing Pools: A Simple Method for Their Evaluation in Practice.	Secondary Salinization of Soils of the Dniester Delta Floodplain.	Implementing Remedial Action Plans to Restore Degraded Areas of the Great Lakes.
W91-10684 5F	W91-10917 2G	W91-11030 6A

6A

Socio-Economic Considerations in Remedial Action Planning for the Great Lakes-A Case	REPRODUCTION Effects of Chlornitrofen, a Herbicide, on Repro-	Seasonal Variations and Relationships of Differ- ent Physico-chemical Characteristics in Newly
Study for Sustainable Development. W91-11031 6A	duction of Brachionus urceolaris (Rotatoria) Through Water and Food (Chlorella).	Made Tawa Reservoir. W91-11528 2H
	W91-11458 5C	
REMEDIAL INVESTIGATION	DECE A DOLL DRIGORIEUS	RESISTANCE
Status Report on Remedial Investigation of the	RESEARCH PRIORITIES  5-Year Scientific Research Programme for Man-	Mechanisms of Resistance to Polychlorinated
300 Area Process Ponds. W91-11583 5G	aging Coastal Seas. W91-10531 2L	Biphenyls (PCB) in Two Species of Marine Dia- toms.
REMEDIATION	W91-10331 2L	W91-11562 5C
Remediation of Floating, Open Water Oil Spills:	Challenge of Sustaining Productivity in the Face	RESOURCE ALLOCATION
Comparative Efficacy of Commercially Avail-	of CO2-Induced Change. W91-11073 5C	North Sea Strategies.
able Polypropylene Sorbent Booms.	W91-110/3	W91-10530 5G
W91-11447 5G	Hydrologic Science: A Distinct Geoscience.	Negotiation Techniques to Resolve Western
REMOTE SENSING	W91-11429 2A	Water Disputes.
ESCCP Cloud Data Products.	RESERVOIR CONSTRUCTION	W91-10817 6E
W91-10479 2B	Distribution and Migration of Heavy Metals in	RESOURCE MANAGEMENT
Comparison of Microwave Techniques for	the Environment of the Altai Mountains in Con-	Crossing the Next Meridian: Sustaining the
Measuring Rainfall.	nection with Ecological Substantiation of the	Lands, Waters, and Human Spirit in the West.
W91-10499 2B	Katun Hydroelectric Station Project. W91-11292 5B	W91-11440 6E
		DESCRIBER DECOVERY
Investigation on Turbidity and Flow Patterns in Half-Closed Sea Area.	RESERVOIR DESIGN	RESOURCE RECOVERY  Recovery of Aquatic Animals in Dokai Bay,
W91-10532 5B	Risk-based Performance Criteria for Real-time	Northern Kyushu, Japan.
1171-10332	Reservoir Operation. W91-11275 4A	W91-10550 5G
Environmental Information Processing of		DECOUDED DEVELOPMENT
Closed Bay Area by Remote Sensing.	RESERVOIR OPERATION	RESOURCES DEVELOPMENT  Crossing the Next Meridian: Sustaining the
W91-10581 7B	Mathematical Modelling for Reservoir Water- Quality Management Through Hydraulic Struc-	Lands, Waters, and Human Spirit in the West.
Analysis of Ground-Probing Radar Data: Pre-	tures: A Case Study.	W91-11440 6E
dictive Deconvolution.	W91-10490 5G	
W91-10782 8G		RESOURCES MANAGEMENT
Use of Single-Doppler Radar for Estimating	Risk-based Performance Criteria for Real-time Reservoir Operation.	Assessing Stream Values: Perspectives of Aquat- ic Resource Professionals.
Maximum Hailstone Size.	W91-11275 4A	W91-11425 8I
W91-10858 2B		
Wind Tonnesteller of a Vanden Marie of the	Selection of the Operating Regime of the Onega-	RESPIRATION
Visual Interpretation of a Landsat Mosaic of the Okavango Delta and Surrounding Area.	Svir' Water System Under Conditions of In- creasing Water Consumption.	Use of Respiration in the Sandy Beach or on the Tidal Flat: 1. Permeable Sandy Beach.
W91-10879 2H	W91-11288 6D	W91-10541 5G
Application of Ground-Penetrating-Radar Meth-	RESERVOIR RELEASES  Macroinvertebrate Responses along a Complex	RESTORATION Aquifer Restoration: Which Method.
ods in Hydrogeologic Studies. W91-10956 7B	Regulated Stream Environmental Gradient.	W91-10486 5G
W 51-10550	W91-10848 4A	W 71-10-00
Multiparameter Radar Estimation of Raindrop	DECEMPAING	Denitrification in Laboratory Sand Columns:
Size Distribution.	RESERVOIRS Perspectives for Ecological Modelling of Tropi-	Carbon Regime, Gas Accumulation and Hy- draulic Properties.
W91-11097 7B	cal and Subtropical Reservoirs in South Amer-	W91-11330 5G
Classification of Snow Cover and Precipitation	ica.	W71-11350
Using the Special Sensor Microwave Imager.	W91-10487 2H	RETAINING WALLS
W91-11219 7B	Features of the Limnological Behavior of Salto	Pressure of Clay Backfill against Retaining
Nature of Suspended Solids and IRS1A-LISSI	Grande's Reservoir (Argentina-Uruguay).	Structures. W91-10947 8D
Data: A Case Study of Tawa Reservoir (Nar-	W91-10491 5C	W 91-10947
mada Basin).	Drivery Deadustivity and Blankton Communi	RETENTION TANKS
W91-11221 5G	Primary Productivity and Plankton Communi- ties in a Two-Reservoir Series.	Dynamic Simulation of Storm Tanks.
NOAA Satellite Data in Natural Oil Slick De-	W91-10815 2H	W91-10928 5D
tection, Otway Basin, Southern Australia.		REVEGETATION
W91-11296 5A	Buffer Strips to Protect Water Supply Reservoirs: A Model and Recommendations.	Revegetation Technologies.
Satellite-Derived Reflectance of Snow-Covered	W91-10816 5G	W91-11568 4D
Surfaces in Northern Minnesota.		REVERSE OSMOSIS
W91-11353 7C	Risk-based Performance Criteria for Real-time	Study on Triple-Membrane-Separator (TMS)
	Reservoir Operation. W91-11275 4A	Process to Treat Aqueous Effluents Containing
Relationship of MSS and TM Digital Data with		Uranium.
Suspended Sediments, Chlorophyll, and Temperature in Moon Lake, Mississippi.	Flow Through Gated Conduits at Partial and	W91-11367 5D
W91-11354 7C	Full Gate Openings. W91-11276 8C	REVIEWS
	W91-112/6	Hydrologic Science: A Distinct Geoscience.
Satellite-Derived Integrated Water-Vapor Dis-	Effect of Hydroelectric Stations on Water Qual-	W91-11429 2A
tribution in Oceanic Midlatitude Storms: Varia-	ity and Development of Phytoplankton in the	REVISED UNIVERSAL SOIL LOSS
tion with Region and Season. W91-11419 2B	Lower Pools of Reservoirs. W91-11289 6G	EQUATION
		RUSLE: Revised Universal Soil Loss Equation.
Assessment of VAS-Derived Retrievals and Pa-	Simplified Phosphorus Trophic State Model for	W91-10510 23
rameters used in Thunderstorm Forecasting. W91-11423 2B	Warm-Water Tropical Lakes. W91-11332 5C	RHINE RIVER
W 71*11743 4B	7.51.777	Rhine Rift Valley Groundwater-River Interac-
Multispectral Satellite Data in the Context of	Local and Seasonal Variation of the Epipelic	tions: Evolution of their Susceptibility to Pollu-
Land Surface Heat Balance.	Algae in Samarra Impoundment, Iraq. W91-11525 2H	tion. W91-10849 5E
W91-11428 7B	W91-11525 2H	11.71-10043 JE

# RHINE RIVER

Methyl and Butyltin Compounds in Water and	Manage Assessment Bassach Startess for	DOTAVIBUODO
Sediments of the Rhine River.  W91-11335  5B	Hazard Assessment Research Strategy for Ocean Disposal. W91-11551 5E	ROTAVIRUSES Rotavirus Detection: A Problem that Needs Concentration.
		W91-10656 5A
RHODE ISLAND Hydrogeology, Water Quality, and Ground- Water Development Alternatives in the Lower	Estimation of Sport Fish Harvest for Risk and Hazard Assessment of Environmental Contami- nants.	Detection of Rotavirus in South African Waters: A Comparison of a Cytoimmunolabelling Tech-
Wood River Ground-Water Reservoir, Rhode	W91-11556 5G	nique with Commercially Available Immunoas-
Island. W91-11572 2F	RIVER BASINS	says. W91-10660 5A
	Salinity and Evaporation in the River Murray	
RHONE RIVER Fluxes and Transport of Anthropogenic and Natural Polycyclic Aromatic Hydrocarbons in	Basin, Australia. W91-10989 2E	Detection of Rotaviruses in Water by Gene Probes.
the Western Mediterranean Sea.	Assessment of Water Pollution using Diatom	W91-10668 5A
W91-10841 5B	Community Structure and Species Distribution— A Case Study in a Tropical River Basin.	Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay.
Processing of Leaves of Trees and Aquatic Ma- crophytes in the Network of the River Rhone.	W91-11404 5C	W91-10696 5A
W91-11402 2H	Regional Approach to Salinity Management in	Comparison of Two Methods for the Recovery
RICE	River Basins. A Case Study in Southern Iran. W91-11432 5G	of Rotavirus from Mussels and Oysters. W91-10697 5A
Effect of Pesticide Treatments on Nontarget Or-		
ganisms in California Rice Paddies. W91-10835 5C	RIVER ELBE Health Risk Assessment of Water Contaminants	ROTIFERS
	Using Baseline Data of Cancer Incidence in Dif-	Alternating Dynamics of Rotifers and Daphnia magna in a Shallow Lake.
RILL EROSION	ferent Water Supply Areas.	W91-10898 2H
WEPP: Soil Erodibility Experiments for Range- land and Cropland Soils.	W91-10614 5F	Effects of Copper and Tributyltin on Stress Pro-
W91-10512 2J	RIVER FLOW	tein Abundance in the Rotifer Brachionus plica-
RIMOV RESERVOIR	Models of Seasonal Growth of the Equatorial	tilis.
Phosphorus Losses from the Epilimnion in	Carp Labeo dussumieri in Response to the River Flood Cycle.	W91-10900 5C
Rimov Reservoir. W91-11401 2H	W91-11559 2H	Rotifers of the Genus Synchaeta-An Important Component of the Zooplankton in the Coastal
	RIVER SYSTEMS	Waters of the Southern Baltic.
RIPARIAN LAND Riparian Zone as a Source of Phosphorus for a	Study of Campylobacter in Sewage, Sewage	W91-11519 2L
Groundwater-Dominated Lake.	Sludge and in River Water. W91-10634 5D	ROUGHNESS COEFFICIENT
W91-10931 2H		Roughness Coefficients of Watercourse Revet-
RIPARIAN VEGETATION	Morphology and Quantitative Analysis of Fluvi- al Erosion Systems in the Hydrological Network	ted With Half-Circular Concrete Pipes. Results of Field Measurements in Watercourse S 333 at
Assessment of the Salinity Tolerance of Eight	of the Basque Country Autonomous Region.	Maarkedal.
Sonoran Desert Riparian Trees and Shrubs. W91-10752 3C	W91-11265 2J	W91-11431 8B
	RIVER TRAINING	RUNOFF
Use of Non-Persistent Herbicides, Glyphosate, and 2,4-D Amine, to Control Riparian Stands of Japanese Knotweed (Reynoutria japonica	Aquatic Macroinvertebrates of the St. Francis Sunken Lands in Northeast Arkansas. W91-10844 4C	Spatial and Temporal Influence of Soil Frost on Infiltration and Erosion of Sagebrush Range- lands.
Houtt). W91-10852 4A		W91-10820 2G
	RIVERS Outflow and Three-Dimensional Spreading of	Self-Affine Scaling and Subsurface Response to
RIPRAP Testing of Cellular Concrete Revetment Blocks	River Water in Enclosed Bay.	Snowmelt in Steep Terrain.
Resistant to Growths of Reynoutria japonica	W91-10525 2L	W91-10912 2G
Houtt (Japanese Knotweed). W91-10942 8F	Citizen's Movements to Protect the Environ-	Geomorphological Dispersion.
	ment of Rivers Flowing into the Seto Inland Sea: An Example of a Citizen's Movement	W91-11232 2E
RISK ASSESSMENT Health-Related Water Microbiology 1990.	Along the Toga River.	Streamflow Generation in a Headwater Basin on
W91-10612 5F	W91-10587 5G	the Precambrian Shield. W91-11349 2E
Health Risk Assessment of Water Contaminants	Computation of Average Seasonal Groundwater	
Using Baseline Data of Cancer Incidence in Dif- ferent Water Supply Areas.	Flows in Phreatic Aquifer-River System. W91-10910 2F	Studies of Springs in the Southern Part of the Valley of Mexico (Estudio Crenologico en la
W91-10614 5F	RNA	Parte Meridional de la Cuenca de Mexico). W91-11352 2E
Use of Risk Assessment for Development of	Growth of Clinical Isolates of Astrovirus in a	
Microbial Standards.	Cell Line and the Preparation of Viral RNA.	RUNOFF FORECASTING
W91-10619 5G	W91-10669 5A	Maximum Entropy View of Probability-Distrib- uted Catchment Models.
Development of Risk Assessment Methodology	PCR and Environmental Monitoring: The Way Forward.	W91-10965 2A
for Land Application and Distribution and Mar- keting of Municipal Sludge.	W91-10670 5A	Runoff Analysis of the Chang Jiang (The
W91-10708 5E	ROCK MECHANICS	Yangtze River). W91-10966 2E
Ecotoxicological Effects Assessment: A Com-	Geotechnical Appraisal of the Foundation Rock	
parison of Several Extrapolation Procedures. W91-10830 5A	Mass Behaviour of Narmada Sagar Dam Project, Central India: A Case Study.	Comparison of Mean Annual Runoff Estimates in the Canadian Portion of the Great Lakes
Oil Spill Risk Simulation Model.	W91-10784 8E	Basin. W91-11020 2E
W91-11001 5B	RODENTS	
Wisconsin's Risk Assessment Based Numerical	Influence of Flooded Soil on Chemical Compo- sition of Annual Ryegrass and Digestibility by	RURAL AREAS Staphylococci in Polluted Waters and in Waters
Groundwater Standards Program.	Meadow Voles.	of Uninhabited Areas.
W91-11183 5G	W91-11536 2I	W91-10631 5B

Rural Clean Water Program. W91-11184 5G	Effect of Low Salinity Water on Salt Displacement in Two Soils.	SAMPLING
30	W91-11433 2G	Improvement of the Zeta-Plus Filter Method for Concentration of Viruses from Water.
Deforestation and Leaching of Nitrogen as Ni- trates into Underground Water in Intertropical	Production Functions Relating Crop Yield,	W91-10655 SA
Zones: The Example of Cote d'Ivoire. W91-11446 2F	Water Quality and Quantity, Soil Salintiy and Drainage Volume.	Rotavirus Detection: A Problem that Needs
	W91-11434 3C	Concentration. W91-10656 5A
SACRAMENTO RIVER Seasonal Influences on the Sediment Transport	SALINIZATION	
Characteristics of the Sacramento River, Cali-	Assessment of the Salinity Tolerance of Eight	Concentration of Hepatitis A Virus in Environ- mental Samples.
fornia. W91-10847 2J	Sonoran Desert Riparian Trees and Shrubs. W91-10752 3C	W91-10658 5A
SACRAMENTO RIVER BASIN	SALMON	Installation of the Westbay Multiport Ground-
Interpretation of Hydrologic Effects of Climate Change in the Sacramento-San Joaquin River	Pacific Salmon at the Crossroads: Stocks at Risk from California, Oregon, Idaho, and Washing-	Water Sampling System in Well 699-43-42K Near The 216-B-3 Pond.
Basin, California.	ton.	W91-10720 7B
W91-11552 5C	W91-10834 8I	Phosphorus in the Truckee River Between Vista
SAGEBRUSH	Shifts in Fish Vertical Distribution in Response to an Internal Seiche in a Stratified Lake.	and Patrick, Storey and Washoe Counties, Nevada, August 1984.
Spatial and Temporal Influence of Soil Frost on Infiltration and Erosion of Sagebrush Range-	W91-10864 2H	W91-10763 5A
lands. W91-10820 2G	SALMONELLA	Field Sampling of Residual Aviation Gasoline in
SALINE-FRESHWATER INTERFACES	Salmonella Detection in Sewage Waters Using Fluorescent Antibodies.	Sandy Soil. W91-10795 5A
Hydrochemistry of a Groundwater-Seawater	W91-10687 5D	
Mixing Zone, Nauru Island, Central Pacific	SALT MARSHES	SAN FRANCISCO BAY
Ocean. W91-11297 2K	Seasonal Variation of Biomass and Production Dynamics for Above and Belowground Compo-	Non-Regulatory Approaches to Management of Coastal Resources and Development in San
SALINE LAKES	nents of a Spartina alterniflora Marsh in the	Francisco Bay. W91-10576 2L
Geomorphic, Geographic, and Hydrographic Basis for Resolving the Mono Lake Controver-	Euhaline Sector of Paranagua Bay (SE Brazil). W91-10495 2L	Environmental Activism in the San Francisco
sy.	Wetland Impoundments of East-Central Florida.	Bay Estuary.
W91-11442 6G	W91-10854 2L	W91-10585 5G
SALINE SOILS Effect of Low Salinity Water on Salt Displace-	Sulfur Enrichment of Humic Substances in a	Providing Access for the Public to the Shoreline
ment in Two Soils.	Delaware Salt Marsh Sediment Core. W91-11258 2L	of San Francisco Bay. W91-10589 6E
W91-11433 2G		CAN TO A OUTN DIVED DACIN
Production Functions Relating Crop Yield, Water Quality and Quantity, Soil Salintiy and	SALT RIVER PROJECT Photographs Written Historical and Descriptive Data.	SAN JOAQUIN RIVER BASIN Interpretation of Hydrologic Effects of Climate Change in the Sacramento-San Joaquin River
Drainage Volume. W91-11434 3C	W91-11577 6E	Basin, California.
	SALVINIA	W91-11552 5C
SALINE WATER  Ambient Water Quality Criteria for Ammonia	Temperatures Lethal to Salvinia molesta Mitch-	SAN JOAQUIN VALLEY
(Saltwater)-1989. W91-10750 5G	ell. W91-11450 2H	Ground-Water Flow and Solute Movement to Drain Laterals, Western San Joaquin Valley,
	SAMARRA RESERVOIR	California. I. Geochemical Assessment. W91-10768 5B
Salinity and Evaporation in the River Murray Basin, Australia.	Local and Seasonal Variation of the Epipelic	
W91-10989 2E	Algae in Samarra Impoundment, Iraq. W91-11525 2H	Ground-Water Flow and Solute Movement to Drain Laterals, Western San Joaquin Valley,
Regional Approach to Salinity Management in	SAMPLE PREPARATION	California. II. Quantitative Hydrologic Assess-
River Basins. A Case Study in Southern Iran. W91-11432 5G	Rotavirus Detection: A Problem that Needs Concentration.	ment. W91-10769 5B
SALINE WATER INTRUSION	W91-10656 5A	Character and Evolution of the Ground-Water
Secondary Salinization of Soils of the Dniester	Concentration of Hepatitis A Virus in Environ-	Flow System in the Central Part of the Western
Delta Floodplain. W91-10917 2G	mental Samples. W91-10658 5A	San Joaquin Valley, California. W91-10772 2F
Analysis of Ground-Water Flow in the A-Sand Aquifer at Paramaribo, Suriname, South Amer-	Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA.	Calibration of a Texture-Based Model of a Ground-Water Flow System, Western San Joa-
ica. W91-11090 2F	W91-10669 5A	quin Valley, California. W91-11101 5B
SALINITY	Rapid Preconcentration Method for Multiele- ment Analysis of Natural Freshwaters.	
Coal Mine Waters and Their Influence on the Purity Ecological State of River and the Fish	W91-10892 7B	SAND AQUIFERS Geochemical Evolution in the Cambrian-Ordo-
Production.	Use of 2,2-Dimethoxypropane for the Direct	vician Sandstone Aquifer, Eastern Wisconsin: 1. Major Ion and Radionuclide Distribution.
W91-10605 5B	Gas Chromatographic-Mass Spectrometric De- termination of Some Organic Compounds in	W01-10053 2K
Assessment of the Salinity Tolerance of Eight	Water.	SAND FLATS
Sonoran Desert Riparian Trees and Shrubs. W91-10752 3C	W91-11245 5A	Annual Bacterial Production in Relation to
	SAMPLE PRESERVATION	Benthic Microalgal Production and Sediment Oxygen Uptake in an intertidal Sandflat and an
Secondary Salinization of Soils of the Dniester Delta Floodplain.	Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay.	Intertidal Mudflat.
W91-10917 2G	W91-10696 5A	W91-10865 2L
Concept of Evaporation from Fresh and Saline		SANITARY ENGINEERING
Water Bodies.	Waters and Sediments.	Rectangular Clarifiers Should Be Considered W91-11223 5D
W91-11244 2D	W91-11255 5A	W 91-11443 3D

5D

### SANITARY ENGINEERING

Case for Circular Clarifiers. W91-11224 5D	Precipitation in Britain: An Analysis of Area- Average Data Updated to 1989.	Satellite-Derived Integrated Water-Vapor Dis- tribution in Oceanic Midlatitude Storms: Varia-
	W91-10973 2B	tion with Region and Season.
SANITATION		W91-11419 2B
Special Report: Water Supply and Sanitation. W91-10482 5F	SCOUR Scour at Cantilevered Pipe Outlets, Plunge, Pool	Models of Seasonal Growth of the Equatorial
Lessons Learned from a Third World Water and	Energy Dissipator Design Criteria. W91-10722 8B	Carp Labeo dussumieri in Response to the River Flood Cycle.
Sanitation Project.	1171-10788	W91-11559 2H
W91-10503 5F	Investigation of Local Scour in Cohesionless	
Winter and Winner World	Sediments Using a Tunnel-Model.	SEAWATER
Water and Human Health. W91-11211 SF	W91-10746 2J	Sea and Fresh Water Conservation.
W91-11211	SEA GRASSES	W91-10578 5G
SAO PAULO	Seagrass-Mangrove Ecosystems Management: A	Determination of Cultural Variation of
Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.	Key to Marine Coastal Conservation in the ASEAN Region.	Determination of Subnanomolar Levels of Iron(II) and Total Dissolved Iron in Seawater by Flow Injection Analysis with Chemilumines-
W91-10685 5D	W91-10539 5G	cence Detection.
SASKATCHEWAN	Balance of Nutrient Losses and Gains in Sea-	W91-10773 2K
Transformation of (C-14)-2,4-Dichlorophenol in	grass Meadows.	ADDOME DAME
Saskatchewan Soils.	W91-10867 2L	SECCHI DISKS
W91-10922 5B	W 91-10807	Secchi Disk and Photometer Estimates of Light
	SEA LEVEL	Regimes in Alaskan Lakes: Effects of Yellow Color and Turbidity.
Implications of Full-Cost Recovery Water Rates on Irrigated Farms in Saskatchewan.	Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware.	W91-10860 2H
W91-11054 6C	W91-10494 2L	CECONDADY WASTEWATED
	W71-10474	SECONDARY WASTEWATER
SATELLITE TECHNOLOGY	SEA OF JAPAN	UV Disinfection of Secondary Effluents from Sewage Treatment Plants.
Environmental Information Processing of	East Asian Seas: Hypothetical Oil Spill Trajec-	W91-10681 5D
Closed Bay Area by Remote Sensing. W91-10581 7B	tories.	W31-10081
W91-10381 /B	W91-10608 5B	SEDIMENT ANALYSIS
Classification of Snow Cover and Precipitation	OTA WATER	Fluxes and Transport of Anthropogenic and
Using the Special Sensor Microwave Imager. W91-11219 7B	SEA WALLS Kansai International Airport Project and Envi-	Natural Polycyclic Aromatic Hydrocarbons in the Western Mediterranean Sea.
	ronmental Impact Assessment.	W91-10841 5B
NOAA Satellite Data in Natural Oil Slick De-	W91-10563 4C	
tection, Otway Basin, Southern Australia.	SEASONAL DISTRIBUTION	SEDIMENT CHEMISTRY
W91-11296 5A	Aquatic Macroinvertebrates of the St. Francis	Chemical Composition of the Interstitial Water
Satellite-Derived Reflectance of Snow-Covered	Sunken Lands in Northeast Arkansas.	in Bottom Sediments of Tyrrhenian Sea (West- ern Mediterranean): Diagenetic Processes.
Surfaces in Northern Minnesota.	W91-10844 4C	W91-10880 2J
W91-11353 7C	Subice Layering and Origin of Acidic Waters in	-
Relationship of MSS and TM Digital Data with Suspended Sediments, Chlorophyll, and Tem-	a Small Boreal Lake During the Spring Runoff. W91-11229 5B	Influence of pH on Phosphate Release from Sediments. W91-11327 2H
perature in Moon Lake, Mississippi. W91-11354 7C	SEASONAL VARIATION	
W)1-11354	Seasonal Variation of Biomass and Production	In-Situ Sediment Oxygen Demand in Five
Satellite-Derived Integrated Water-Vapor Dis-	Dynamics for Above and Belowground Compo-	Southwestern U.S. Lakes.
tribution in Oceanic Midlatitude Storms: Varia-	nents of a Spartina alternislora Marsh in the	W91-11333 2H
tion with Region and Season.	Euhaline Sector of Paranagua Bay (SE Brazil).	Sediment Denitrification Potential in the Eliza-
W91-11419 2B	W91-10495 2L	beth River, Virginia.
Assessment of VAS-Derived Retrievals and Pa-	Seasonal Changes of Organic Carbon and Nitro-	W91-11537 5C
rameters used in Thunderstorm Forecasting.	gen Production by Phytoplankton in the Estuary	
W91-11423 2B	of River Tamagawa.	SEDIMENT CONCENTRATION
1171 1110	W91-10604 5B	Effects of Suspended Sediments on Aquatic
Multispectral Satellite Data in the Context of		Ecosystems.
Land Surface Heat Balance.	Studies of Dissolved Carbohydrates (or Carbo-	W91-11426 5C
W91-11428 7B	hydrate-Like Substances) in an Estuarine Envi-	SEDIMENT CONTAMINATION
SAVANNAH RIVER PLANT	ronment.	
Comprehensive Cooling Water Study, Final	W91-10840 2L	Meiofauna of an Experimental Soft Bottom Eco- systemEffects of Macrofauna and Cadmium
Report. Volume I: Summary of Environmental	Seasonal Influences on the Sediment Transport	Exposure.
Effects.	Characteristics of the Sacramento River, Cali-	W91-10519 5C
W91-10729 5B	fornia.	***************************************
	W91-10847 2J	Heavy Metal Pollution in Sediment from the
SCALING		Seto Inland Sea, Japan.
Computer Modeling of Scale Formation During	Computation of Average Seasonal Groundwater	W91-10537 5B
Treatment of Ground Water in Air Strippers. W91-10798 5G	Flows in Phreatic Aquifer-River System. W91-10910 2F	Benthic Faunal Succession in a Cove Organical-
		ly Polluted by Fish Farming.
SCENEDESMUS	Spring and Summer 1988 Drought over the	W91-10554 5C
1-Naphthalenesulfonic acid and Sulfate as Sulfur	Contiguous United StatesCauses and Predic-	Total Andrews and Andrews
Sources for the Green Alga Scenedesmus obli-	tion.	Integrated Management of the Baltic Sea.
quus. W91-11326 5D	W91-11412 2B	W91-10580 5G
W71-11320 SD	Spatial Distribution of Precipitation Seasonality	Heavy Metals Contamination in the Polish Zone
SCOTLAND	in the United States.	of Southern Baltic.
Occurrence of Cryptosporidium spp. Oocysts in	W91-11414 2B	W91-10597 5B
Scottish Waters, and the Development of a		
Fluorogenic Viability Assay for Individual	Spatial Distribution of Rainfall in the Greater	Computer Visualization System for Sediment
Cryptosporidium Oocysts.	Athens Area.	Pollution in Japan.
W91-10645 5B	W91-11416 2B	W91-10609 7C

Behavior of Heavy Metals in a Mud Flat of the	Flood-Hazard Zonation in Arid Lands.	SEISMIC WAVES
Scheldt Estuary, Belgium. W91-10872 5B	W91-11390 6F	Seismic Hazard at Narmada Sagar Dam.
W91-10872 5B	SEDIMENT-WATER INTERFACES	W91-10949 8E
Delay in Lake Recovery Caused by Internal	Macroalgal-Sediment Nutrient Interactions and	SELENIUM
Loading.	Their Importance to Macroalgal Nutrition in a	Ground-Water Flow and Solute Movement to
W91-10886 2H	Eutrophic Estuary.	Drain Laterals, Western San Joaquin Valley,
Acoustic Parametric Array for Measuring the	W91-10497 2L	California. I. Geochemical Assessment.
Thickness and Stratigraphy of Contaminated	Use of Respiration in the Sandy Beach or on the	W91-10768 5B
Sediments.	Tidal Flat: 1. Permeable Sandy Beach.	Ground-Water Flow and Solute Movement to
W91-10981 2J	W91-10541 5G	Drain Laterals, Western San Joaquin Valley,
Distribution of Chlorobenzenes in the Bottom	Debusies of House Matels in a Mad Plat of the	California. II. Quantitative Hydrologic Assess-
Sediments of Ise Bay.	Behavior of Heavy Metals in a Mud Flat of the Scheldt Estuary, Belgium.	ment.
W91-11324 5B	W91-10872 5B	W91-10769 5B
Methyl and Dutyltin Compounds in Water and		Subchronic Hepatotoxicity of Selenomethionine
Methyl and Butyltin Compounds in Water and Sediments of the Rhine River.	In-Situ Sediment Oxygen Demand in Five	Ingestion in Mallard Ducks.
W91-11335 5B	Southwestern U.S. Lakes. W91-11333 2H	W91-10838 5C
W	W91-11333 2H	
Major Incident of Dioxin Contamination: Sedi- ments of New Jersey Estuaries.	SEDIMENTATION	Patella vulgata, Mytilus minimus and Hyale pre-
W91-11341 5B	Sediment Transport on the Foreshore.	vosti as Bioindicators for Pb and Se Enrichment in Alexandria Coastal Waters.
	W91-10599 2L	W91-10875 5A
Phenyltins in Water, Sediment, and Biota of	Chemical Composition of the Interstitial Water	1171-10075
Freshwater Marinas. W91-11342 5B	in Bottom Sediments of Tyrrhenian Sea (West-	Management of Irrigation-Induced Contami-
W91-11342 5B	ern Mediterranean): Diagenetic Processes.	nants.
Heavy Metal Distribution in the Godvari River	W91-10880 2J	W91-11063 5G
Basin.	Open Channel Velocity Profiles over a Zone of	Calibration of a Texture-Based Model of a
W91-11445 5B	Rapid Infiltration.	Ground-Water Flow System, Western San Joa-
Sediment Denitrification Potential in the Eliza-	W91-10984 8B	quin Valley, California.
beth River, Virginia.		W91-11101 5B
W91-11537 5C	Dendrogeomorphic Approach to Measurement	Determination of Selenium Species in Spent Oil
SEDIMENT DISTRIBUTION	of Sedimentation in a Forested Wetland, Black Swamp, Arkansas.	Shale Leachates by Ion Chromatography.
Recent Sedimentation in Lake Michigan.	W91-11397 2H	W91-11553 5B
W91-10976 2J		
	SEDIMENTATION RATES	SEMIARID LANDS
SEDIMENT LOAD	Organic Carbon Accumulation in Baffin Bay	Point-Infiltration Model for Estimating Runoff
Heavy Metal Distribution in the Godvari River Basin.	and Paleoenvironment in High Northern Lati- tudes During the Past 20 m. y.	from Rainfall on Small Basins in Semiarid Areas of Wyoming.
W91-11445 5B	W91-10791 2J	W91-11585 2E
	1171-10171	W 71-11363
SEDIMENT OXYGEN DEMAND	Recent Sedimentation in Lake Michigan.	SENSITIVITY ANALYSIS
In-Situ Sediment Oxygen Demand in Five Southwestern U.S. Lakes.	W91-10976 2J	Modelling Water and Solute Transport in Ma-
W91-11333 2H	Phosphorus Losses from the Epilimnion in	croporous Soil. I. Model Description and Sensi-
	Rimov Reservoir.	tivity Analysis. W91-10803 5B
SEDIMENT SAMPLER	W91-11401 2H	W 91-10003
Changes with Time of the Transport Rate of	SEDIMENTOLOGY	Great Lakes Total Phosphorus Model: Post
Sediment Mixtures. W91-10988 7B	Reactive Continuum Representation of Organic	Audit and Regionalized Sensitivity Analysis.
W 51-10500	Matter Diagenesis.	W91-10974 2H
SEDIMENT SAMPLING	W91-11448 2J	Comparison of Amperometric and UV-Spectro-
Changes with Time of the Transport Rate of		photometric Monitoring in the HPLC Analysis
Sediment Mixtures. W91-10988 7B	SEDIMENTS Change with Time of the Tonoger Pete of	of Pesticides.
W 51-10566	Changes with Time of the Transport Rate of Sediment Mixtures.	W91-11306 5A
SEDIMENT TRANSPORT	W91-10988 7B	CEDADATION TECHNIQUES
First-Order Organic Carbon Budget in the St		SEPARATION TECHNIQUES  Chromatographic Separation of Arsenic Species
Lawrence Lower Estuary from 13C Data. W91-10498 2L	SEEPAGE	with Sodium Bis(trifluoroethyl)dithiocarbamate
	Environmental Isotope Study for Estimating Leakage and Runoff of Ground Waters in the	Chelation.
Fluidization of Marine Mud by Waves.	Xi'an Area.	W91-10894 5A
W91-10533 5B	W91-10994 2F	T
Sediment Transport on the Foreshore.		Extraction of Heavy Metals from Sludges and Muds by Magnetic Ion-Exchange.
W91-10599 2L	SEEPAGE LOSS	W91-11145 5D
	Ground-Water Control of Evaporite Deposition. W91-11438 2K	W31-11145
Organic Carbon Accumulation in Baffin Bay	W91-11430 2K	Selective Concentration of Lead(II) Chloride
and Paleoenvironment in High Northern Lati- tudes During the Past 20 m. y.	SEICHES	Complex With Liquid Anion-Exchange Mem-
W91-10791 2J	Shifts in Fish Vertical Distribution in Response	branes.
	to an Internal Seiche in a Stratified Lake.	W91-11247 5D
Seasonal Influences on the Sediment Transport	W91-10864 2H	Multi-Residue-Analysis of Pesticides by HPLC
Characteristics of the Sacramento River, Cali-	SEISMIC PROPERTIES	after Solid Phase Extraction.
fornia. W91-10847 2J	Seismic Fracture Analysis of Concrete Gravity	W91-11307 5A
	Dams.	Determination of Herbirth Buildon is Call in
Changes with Time of the Transport Rate of	W91-10787 8F	Determination of Herbicide Residues in Soil in the Presence of Persistent Organochlorine Insec
Sediment Mixtures. W91-10988 7B	SEISMIC SURVEYS	ticides.
W91-10988 7B	Application of Uphole Data from Petroleum	
Distance of Movement of Coarse Particles in	Seismic Surveys to Groundwater Investigations,	
Gravel Bed Streams.	Abu Dhabi (United Arab Emirates).	Analysis of 10 Selected Herbicides in Water
W91-11231 2J	W91-11399 7C	W91-11311 5A

### SEPARATION TECHNIQUES

Solid-Phase Extraction for Multi-Residue Analy-	SHALLOW WELLS	SIMULATED RAINFALL
sis of Some Triazole and Pyrimidine Pesticides	Method for Installing Miniature Multilevel Sam-	Three-Dimensional Simulation of Airflow and
in Water.	pling Wells.	Orographic Rain Over the Island of Hawaii.
W91-11313 5A	W91-10962 5A	W91-10517 2B
		W >1-10317
Use of Ligand-Modified Micellar-Enhanced Ul-	SHEAR STRESS	SIMULATION
trafiltration in the Selective Removal of Metal Ions from Water.	Open Channel Velocity Profiles over a Zone of	Simulation of Precipitation by Weather Type
W91-11318 5D	Rapid Infiltration. W91-10984 8B	Analysis.
W91-11316	W 71-10764 8B	W91-11230 2B
Use of a Single-Bowl Continuous-Flow Centri-	SHEEP DIP	
fuge for Dewatering Suspended Sediments:	Sheep-Dips as a Source of Pollution of Fresh-	SIMULATION ANALYSIS
Effect on Sediment Physical and Chemical	waters: A Study in Grampian Region.	Dynamic Simulation of Storm Tanks.
Characteristics.	W91-11356 5B	W91-10928 5D
W91-11350 7B	SHELLFISH	Oil Saill Bisk Simulation Model
Liquid Effluents: New Solutions to Old Prob-	Assessment of Methods for the Microbiological	Oil Spill Risk Simulation Model. W91-11001 5B
lems.	Analysis of Shellfish.	W91-11001 5B
W91-11360 5D	W91-10695 5A	Simulated Hydrologic Effects of Climatic
		Change in the Delaware River Basin.
Application of Supported Liquid Membranes for	Detoxification by Sephadex LH20 of Seafood	W91-11060 5C
Removal of Uranium From Groundwater. W91-11370 5G	Concentrates for Rotavirus Assay. W91-10696 5A	
W31-113/0	W 91-10090	Geohydrology and Simulation of Ground-Water
Synthesis and Decomposition of Novel Organo-	Comparison of Two Methods for the Recovery	Flow in the Mesilla Basin, Dona Ana County,
phosphorus Complexants.	of Rotavirus from Mussels and Oysters.	New Mexico, and El Paso County, Texas.
W91-11372 5D	W91-10697 5A	W91-11088 2F
EPTIC TANKS	Comparison of Methods for the Isolation of a	Multiparameter Radar Estimation of Raindrop
Innovative Subsurface Sewage Management: A	Comparison of Methods for the Isolation of a Wide Range of Viruses from Shellfish.	Size Distribution.
Program to Protect Idaho's Rathdrum Prairie	W91-10698 5A	W91-11097 7B
Aquifer.	W71-10076	W31-11097 /B
W91-11186 5G	SHIRISH	Geohydrology and Simulation of Flow in the
	Influence of Leaf Leachate-Enriched Water of	Chicot Aquifer System of Southwestern Louisi-
EPTIC WASTEWATER	Neem (Azadirachta indica A. Juss.) and Shirish	ana.
Innovative Subsurface Sewage Management: A	(Albizzia lebbek Benth.) on the Growth of Eich-	W91-11100 2F
Program to Protect Idaho's Rathdrum Prairie	hornia crassipes (Mart.) Solms.	
Aquifer.	W91-11449 2I	Characterization and Simulation of Rainfall-
W91-11186 5G	SHORELINE MANAGEMENT PLAN	Runoff Relations for Headwater Basins in West-
ETO INLAND SEA	Provincial Guidelines to Great Lakes Shoreline	ern King and Snohomish Counties, Washington.
Meteorology and Oceanography in the Seto	Management Plans.	W91-11592 2A
Inland Sea.	W91-11024 6E	SITE REMEDIATION
W91-10520 2L	SHORELINES	Use of Respiration in the Sandy Beach or on the
Water Exchange and Transport of Matter in the	Sediment Transport on the Foreshore.	Tidal Flat: 1. Permeable Sandy Beach.
Seto Inland Sea.	W91-10599 2L	W91-10541 5G
W91-10527 2L	***************************************	
	SHORES	Superfund Record of Decision: Commencement
Heavy Metal Pollution in Sediment from the	Impact of Coastal Development on the Infralit-	Bay/S. Tacoma, WA.
Seto Inland Sea, Japan.	toral Zone Along the Southeastern Mediterrane-	W91-10711 5G
W91-10537 5B	an Shore of Continental France.	
Summary of Ports and Marine Environment Im-	W91-10562 6G	Treatability of Hazardous Chemicals in Soils:
provement Work and Example of Latest Meas-	Providing Access for the Public to the Shoreline	Volatile and Semivolatile Organics.
ures in Seto Inland Sea.	of San Francisco Bay.	W91-10712 5B
W91-10545 5G	W91-10589 6E	Superfund Record of Decision: South Valley
TIC C. I. C	CHARLES II	(PL-83), NM.
Life Cycle Strategies of the Red Tide Causing	SICILY	W91-10721 5G
Flagellates Chattonella (Raphidophyceae) in the Seto Inland Sea.	Man-Made Garbage Pollution on the Mediterra- nean Coastline.	***************************************
W91-10546 5B	W91-10569 5B	Superfund Record of Decision: Reich Farms,
35		NJ.
Bloom of Coscinodiscus wailesii and DO Deficit	SIERRA LEONE	W91-10743 5G
of Bottom Water in Seto Inland Sea.	Socio-Economic Impact of Improved Wells in	
W91-10549 5C	Rural Sierra Leone.	Superfund Record of Decision. Mid-State Dis-
Environmental Management of the Seto Inland	W91-11358 6B	posal Landfill, WI.
Sea.	SILICA	W91-10749 5G
W91-10573 5G	Fate of Silicate Minerals in a Peat Bog.	Superfund Record of Decision: Kin-Buc Land-
	W91-10789 2H	fill, NJ.
Citizen's Movements to Protect the Environ-		W91-10755 5G
ment of Rivers Flowing into the Seto Inland	Size Structure of Particulate Biogenic Silica in	
Sea: An Example of a Citizen's Movement	Lake Michigan.	Superfund Record of Decision: Palmerton Zinc
Along the Toga River. W91-10587 5G	W91-10975 2H	Pile, PA.
W91-10587 5G	SILICATES	W91-10756 5G
Water Control Systems and the Traditional Fes-	Fate of Silicate Minerals in a Peat Bog.	Superfund Record of Decision: South Valley/
tival at Miyawaki, on the Seto Inland Sea.	W91-10789 2H	Edmunds Street, NM.
W91-10591 3F	CHAND	W91-10758 5G
SEWAGE	SILVER Pathways of Silver Uptake and Trophic Trans-	
Hong Kong: Can the Dragon Clean its Nest.	fer in Estuarine Organisms.	Superfund Record of Decision: Celanese Fibers
W91-11439 5G	W91-11337 5B	Operations, NC.
		W91-10759 5G
SHALLOW WATER EQUATIONS	SIMAZINE	
Similarity Solutions of the Shallow Water Equa-	Simazine Concentrations in a Stream Draining	Aqueous Surfactant Washing of Residual Oi
tions. W91-10987 8B	an Agricultural Catchment.	Contamination from Sandy Soil.

Development and Implementation of a Remedial Investigation Work Plan and Data Management	SLUDGE CONDITIONING Influence of Polyelectrolyte Characteristics on	Alternative Uses of Sludge Other than Agricul- tural.
System.	Sludge Conditioning (Lab Evaluations).	W91-11120 5E
W91-10799 5G	W91-10701 5D	Modern Sludge Management: The Manager's
Superfund Record of Decision: Intel (Mountain View), CA.	Examples of Agricultural Use of Residual Sludge.	Choice. W91-11122 5D
W91-11581 5G	W91-11139 5D	
Superfund Record of Decision: Whitmoyer Lab-	Sludge Dewatering: First Membrane Filterpress	Pathway Analysis of Selected Organic Chemi- cals from Sewage to Agricultural Soil.
oratories, PA.	Plant in the Netherlands Operational.	W91-11123 5B
W91-11582 5G	W91-11155 5D	Organic Substances in Soils and Plants after
Status Report on Remedial Investigation of the	SLUDGE DIGESTION	Intensive Applications of Sewage Sludge.
300 Area Process Ponds. W91-11583 5G	Destruction of Faecal Bacteria, Enteroviruses	W91-11126 5E
	and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophi-	High-Pressure Dewatering with Polymer Condi-
Assessment of International Technologies for Superfund Applications.	lic Digestion. W91-10688 5D	tioning as a Prerequisite for the Energy-Inde- pendent Incineration of Sewage Sludge.
W91-11584 5G	W91-10088	W91-11127 5D
SLIDE GATES	New Developments in Processing of Sludges	Technical Requirements and Possibilities of In-
Flow Through Gated Conduits at Partial and	and Slurries. W91-10699 5D	cineration.
Full Gate Openings. W91-11276 8C	Acarbia Thermonbilia Dispution of Bea Thick	W91-11129 5D
	Aerobic Thermophilic Digestion of Pre-Thick- ened Sludge Using Air.	Environmental Aspects of Sludge Incineration:
SLOPE STABILITY	W91-10704 5D	Overview. W91-11130 5E
September 5, 1987, Landslide on the La Grande River, James Bay, Quebec, Canada.	Este and Effects of Saminalatile Orannia Ballut	W91-11130 5E
W91-10946 2J	Fate and Effects of Semivolatile Organic Pollut- ants During Anaerobic Digestion of Sludge.	Sewage Sludge Incineration and Utilization of
SLOPES	W91-10884 5D	Energy. W91-11131 5D
Soil Water Dynamics Related to Waterlogging	Status Report on Environment Canada's Oil	W91-11131
in a Sloping Catchment.	From Sludge Technology.	Influences on the Mechanical Properties of
W91-10906 2G	W91-11133 5D	Sewage Sludge for Disposal to Landfill. W91-11135 5D
Self-Affine Scaling and Subsurface Response to	Thermophilic Aerobic Stabilisation.	Projection of Landfillian Studen
Snowmelt in Steep Terrain. W91-10912 2G	W91-11134 5D	Environmental Aspects of Landfilling Sludge. W91-11136 5E
Dedenous bis Assessed to Estimation	Stabilization of Sewage Sludge and Its Disinfec-	Sludge Recycling in Agriculture Compared with
Dendrogeomorphic Approach to Estimating Slope Retreat, Maxey Flats, Kentucky.	tion According to Specific Requirements: Two- Stage Anaerobic/Aerobic Operating Tech-	Other Disposal Methods in France.
W91-11395 2D	niques.	W91-11137 5E
SLUDGE	W91-11141 5D	Use of Municipal Sewage Sludge in Agriculture:
Study of Campylobacter in Sewage, Sewage Sludge and in River Water.	Aerobic-Thermophilic Methods for Disinfecting	The Role of the Water Authorities. W91-11138 5D
W91-10634 5D	and Stabilizing Sludge. W91-11143 5D	
Distribution of Giardia Custs in Wasterman		Examples of Agricultural Use of Residual Sludge.
Distribution of Giardia Cysts in Wastewater. W91-10649 5B	Laboratory Studies of Virus Survival During Aerobic and Anaerobic Digestion of Sewage	W91-11139 5D
Physical and Chemical Characterization of	Sludge.	Sludge Treatment and Tipping Site 'Hartel-
Sewage Sludge.	W91-11319 5D	mond'. W91-11140 5D
W91-11117 5D	SLUDGE DISPOSAL	W91-11140
Sludge Reduction Possibilities as Demonstrated	New Developments in Processing of Sludges	Extraction of Heavy Metals from Sludges and
by the Chemolysis Process Dow Stade GmbH. W91-11118 5D	and Slurries. W91-10699 5D	Muds by Magnetic Ion-Exchange. W91-11145 5D
	Dutch Approach to Manure Processing.	Wet Oxydation as the Alternative for Sewage
Methods of Applying Sewage Sludge to Land: A Review of Recent Developments.	W91-10703 5D	Sludge Treatment.
W91-11119 5E	Processing Organic Waste Products to Black	W91-11146 5D
Alternative Uses of Sludge Other than Agricul-	Soil and Organic Fertilizers.	Modifications of Some Physical Properties is
tural.	W91-10705 5E	Two Compost-Amended Italian Soils.
W91-11120 5E	Development of Risk Assessment Methodology	W91-11148 5E
Odour Problems with Sewage Sludge.	for Land Application and Distribution and Mar-	Composting Raw Sewage Sludge in the Absence
W91-11121 5D	keting of Municipal Sludge. W91-10708 5E	of Bulking Agents. W91-11149 5E
Pathway Analysis of Selected Organic Chemi-		
cals from Sewage to Agricultural Soil.	Sewage Sludge Treatment and Use: New Devel- opments, Technological Aspects and Environ-	Use of Sewage Sludge on Agricultural Land
W91-11123 5B	mental Effects.	Impact on Soil Fauna. W91-11150 5I
SLUDGE ANALYSIS	W91-11115 5E	
Recovery of Enterovirus from Primary Sludge	Production, Treatment and Handling of Sewage	Effects of Sewage Sludge and Waste Compos on Some Soil Enzymatic Activities Tested in
Using Three Elution Concentration Procedures. W91-10657 5A	Sludge.	Field Experiment.
Sludge Treatment in Amsterdam: Economical,	W91-11116 5D	W91-11151 51
Technical and Environmental Experiences.	Physical and Chemical Characterization of	Existing Conditions for Agricultural Utilization
W91-11132 5D		of Sewage Sludge Compost in Japan. W91-11152 51
SLUDGE BED	W91-11117 5D	
Denitrification by Thermophilic Soil Bacteria	Methods of Applying Sewage Sludge to Land:	Production of Compost from Sewage Sludge i
With Ethanol as Substrate in a USB Reactor.		Tokyo. W91-11153 51

## SLUDGE DISPOSAL

	Hanny Matel Consisting in Course Cludes Tal	A bis The
Beneficial Utilization of Incinerated Ash and	Heavy Metal Speciation in Sewage Sludge Fol-	Aerobic Thermophilic Digestion of Pre-Thick-
Melted Slag. W91-11154 5E	lowing a Phyto-Dewatering Treatment. W91-11147 5D	ened Sludge Using Air. W91-10704 5D
W91-11134 3E	W71-11147 3D	W91-10/04 3D
Sludge Studies on Sludge Management: Strate-	Production of Compost from Sewage Sludge in	Sludge Management by Thermal Conversion to
gic Studies on Sludge.	Tokyo.	Fuels.
W91-11156 5D	W91-11153 5E	W91-10706 5D
	01 1 P PI . 14 1 PI	
Studies for a Simultaneous Use of Liquid	Sludge Dewatering: First Membrane Filterpress	Role of Biotechnology in the Treatment of Geo-
Manure and Sewage Sludge.	Plant in the Netherlands Operational.	thermal Residual Sludges.
W91-11157 5E	W91-11155 5D	W91-10744 5D
New Developments in Sampling Sludge Treated	SLUDGE FILTERS	
Soils.	CHP-Filter PressThe First Continuous High-	Sewage Sludge Treatment and Use: New Devel-
W91-11158 5A	Pressure Filter Press.	opments, Technological Aspects and Environ-
W31-11130	W91-10702 5D	mental Effects.
Chemical Properties of Sewage Sludges Pro-		W91-11115 5E
duced in the Valencian Area (Spain).	Sludge Dewatering: First Membrane Filterpress	Production, Treatment and Handling of Sewage
W91-11159 5A	Plant in the Netherlands Operational.	Sludge.
	W91-11155 5D	W91-11116 5D
Microbial Biomass and Biological Activities in	SLUDGE STABILIZATION	W91-11110
an Acid Sandy Soil Treated with Sewage Sludge	Accumulation of Refractory 4-Nonylphenol	Physical and Chemical Characterization of
or Farmyard Manure in a Long Term Field	During Mesophilic Anaerobic Sludge Stabiliza-	Sewage Sludge.
Experiment.	tion.	W91-11117 5D
W91-11160 5E	W91-10707 5D	
Laboratory Studies of Virus Survival During	***************************************	Sludge Reduction Possibilities as Demonstrated
Aerobic and Anaerobic Digestion of Sewage	Stabilization of Sewage Sludge and Its Disinfec-	by the Chemolysis Process Dow Stade GmbH.
Sludge.	tion According to Specific Requirements: Two-	W91-11118 5D
W91-11319 5D	Stage Anaerobic/Aerobic Operating Tech-	
0.0	niques.	Odour Problems with Sewage Sludge.
Agronomic Effects of Land Application of	W91-11141 5D	W91-11121 5D
Water Treatment Sludges.	A seek le The see a little billed at the Thirty County	
W91-11459 4C	Aerobic-Thermophilic Methods for Disinfecting	Modern Sludge Management: The Manager's
	and Stabilizing Sludge. W91-11143 5D	Choice.
Treatment Technologies for Organochlorine-	W91-11143 3D	W91-11122 5D
Containing Sludges and Concentrates from Ex-	SLUDGE THICKENING	Pathway Analysis of Selected Organic Chemi-
ternal Treatment of Pulp and Paper Wastewaters.	Application of Electrical Fields to Thicken and	cals from Sewage to Agricultural Soil.
	Dewater Sewage Sludges.	W91-11123 5B
W91-11500 5D	W91-10700 5D	W91-11123 3B
Thermocatalytic and Chemical Treatment of		Removal of Heavy Metals from Sewage Sludge:
Lignin-Aluminium Sludge and Utilization of the	Aerobic Thermophilic Digestion of Pre-Thick-	State of the Art and Perspectives.
Resulting Adsorbent-Coagulant.	ened Sludge Using Air.	W91-11124 5D
W91-11503 5D	W91-10704 5D	
	High-Pressure Dewatering with Polymer Condi-	Improvement of the Quality of Sewage Sludge:
SLUDGE DRYING	tioning as a Prerequisite for the Energy-Inde-	Microbiological Aspects.
Application of Electrical Fields to Thicken and	pendent Incineration of Sewage Sludge.	W91-11125 5D
Dewater Sewage Sludges.		
W91-10700 5D	W91-11127 5D	High-Pressure Dewatering with Polymer Condi-
W91-10700 5D		tioning as a Prerequisite for the Energy-Inde-
W91-10700 5D  Influence of Polyelectrolyte Characteristics on	W91-11127 5D	tioning as a Prerequisite for the Energy-Inde- pendent Incineration of Sewage Sludge.
W91-10700 5D Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations).	W91-11127 5D Sludge Dewatering Technology in Perspective. W91-11128 5D	tioning as a Prerequisite for the Energy-Inde-
W91-10700 5D  Influence of Polyelectrolyte Characteristics on	W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Chemolysis Process of Dow Stade GMBH.	tioning as a Prerequisite for the Energy-Inde- pendent Incineration of Sewage Sludge. W91-11127 5D
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D	W91-11127 5D Sludge Dewatering Technology in Perspective. W91-11128 5D	tioning as a Prerequisite for the Energy-Inde- pendent Incineration of Sewage Sludge. W91-11127 5D Sludge Dewatering Technology in Perspective.
W91-10700 5D Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations).	W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Chemolysis Process of Dow Stade GMBH. W91-11144 5D	tioning as a Prerequisite for the Energy-Inde- pendent Incineration of Sewage Sludge. W91-11127 5D
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press.	W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Chemolysis Process of Dow Stade GMBH. W91-11144 5D  SLUDGE TREATMENT	tioning as a Prerequisite for the Energy-Inde- pendent Incineration of Sewage Sludge. W91-11127 5D Sludge Dewatering Technology in Perspective. W91-11128 5D
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press-The First Continuous High-Pressure Filter Press. W91-10702 5D	W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Chemolysis Process of Dow Stade GMBH. W91-11144 5D  SLUDGE TREATMENT Clostridium perfringens, as an Indicator Micro-	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge. W91-11127 5D Sludge Dewatering Technology in Perspective. W91-11128 5D Technical Requirements and Possibilities of In-
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High- Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Devel-	W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Chemolysis Process of Dow Stade GMBH. W91-11144 5D  SLUDGE TREATMENT	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Technical Requirements and Possibilities of Incineration.
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environ-	W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Chemolysis Process of Dow Stade GMBH. W91-11144 5D  SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge. W91-11127 5D Sludge Dewatering Technology in Perspective. W91-11128 5D Technical Requirements and Possibilities of In-
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects.	W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Chemolysis Process of Dow Stade GMBH. W91-11144 5D  SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Technical Requirements and Possibilities of Incineration. W91-11129 5D
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environ-	W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Chemolysis Process of Dow Stade GMBH. W91-11144 5D  SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D  Destruction of Faecal Bacteria, Enteroviruses	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Technical Requirements and Possibilities of Incineration.
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E	W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Chemolysis Process of Dow Stade GMBH. W91-11144 5D  SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D  Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127  SD  Sludge Dewatering Technology in Perspective. W91-11128  Technical Requirements and Possibilities of Incineration. W91-11129  SD  Environmental Aspects of Sludge Incineration:
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage	W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Chemolysis Process of Dow Stade GMBH. W91-11144 5D  SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D  Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophi-	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127  SD  Sludge Dewatering Technology in Perspective. W91-11128  Technical Requirements and Possibilities of Incineration. W91-11129  Environmental Aspects of Sludge Incineration: Overview. W91-11130  5E
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge.	W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Chemolysis Process of Dow Stade GMBH. W91-11144 5D  SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D  Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion.	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Technical Requirements and Possibilities of Incineration. W91-11129 5D  Environmental Aspects of Sludge Incineration: Overview. W91-11130 5E  Sewage Sludge Incineration and Utilization of
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage	W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Chemolysis Process of Dow Stade GMBH. W91-11144 5D  SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D  Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophi-	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge. W91-11127 5D Sludge Dewatering Technology in Perspective. W91-11128 5D Technical Requirements and Possibilities of Incineration. W91-11129 5D Environmental Aspects of Sludge Incineration: Overview. W91-11130 5E Sewage Sludge Incineration and Utilization of Energy.
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge. W91-11116 5D	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Technical Requirements and Possibilities of Incineration. W91-11129 5D  Environmental Aspects of Sludge Incineration: Overview. W91-11130 5E  Sewage Sludge Incineration and Utilization of
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge.	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D Control of Enteric Micro-organisms by Aerobic-	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Technical Requirements and Possibilities of Incineration. W91-11129 5D  Environmental Aspects of Sludge Incineration: Overview. W91-11130 5E  Sewage Sludge Incineration and Utilization of Energy. W91-11131 5D
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge. W91-11116 5D  Sludge Reduction Possibilities as Demonstrated	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D Control of Enteric Micro-organisms by Aerobic-Thermophilic Co-Composting of Wastewater	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Technical Requirements and Possibilities of Incineration. W91-11129 5D  Environmental Aspects of Sludge Incineration: Overview. W91-11130 5E  Sewage Sludge Incineration and Utilization of Energy. W91-11131 5D  Sludge Treatment in Amsterdam: Economical,
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge. W91-11116 5D  Sludge Reduction Possibilities as Demonstrated by the Chemolysis Process Dow Stade GmbH. W91-11118 5D	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D Control of Enteric Micro-organisms by Aerobic-Thermophilic Co-Composting of Wastewater Sludge and Agro-Industry Sludge.	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge. W91-11127 5D Sludge Dewatering Technology in Perspective. W91-11128 5D Technical Requirements and Possibilities of Incineration. W91-11129 5D Environmental Aspects of Sludge Incineration: Overview. W91-11130 5E Sewage Sludge Incineration and Utilization of Energy. W91-11131 5D Sludge Treatment in Amsterdam: Economical, Technical and Environmental Experiences.
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge. W91-11116 5D  Sludge Reduction Possibilities as Demonstrated by the Chemolysis Process Dow Stade GmbH. W91-11118 5D  High-Pressure Dewatering with Polymer Condi-	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D Control of Enteric Micro-organisms by Aerobic-Thermophilic Co-Composting of Wastewater Sludge and Agro-Industry Sludge. W91-10693 5E	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Technical Requirements and Possibilities of Incineration. W91-11129 5D  Environmental Aspects of Sludge Incineration: Overview. W91-11130 5E  Sewage Sludge Incineration and Utilization of Energy. W91-11131 5D  Sludge Treatment in Amsterdam: Economical,
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge. W91-11116 5D  Sludge Reduction Possibilities as Demonstrated by the Chemolysis Process Dow Stade GmbH. W91-11118 5D  High-Pressure Dewatering with Polymer Conditioning as a Prerequisite for the Energy-Inde-	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D Control of Enteric Micro-organisms by Aerobic-Thermophilic Co-Composting of Wastewater Sludge and Agro-Industry Sludge. W91-10693 5E New Developments in Processing of Sludges	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Technical Requirements and Possibilities of Incineration. W91-11129 5D  Environmental Aspects of Sludge Incineration: Overview. W91-11130 5E  Sewage Sludge Incineration and Utilization of Energy. W91-11131 5D  Sludge Treatment in Amsterdam: Economical, Technical and Environmental Experiences. W91-11132 5D
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge. W91-11116 5D  Sludge Reduction Possibilities as Demonstrated by the Chemolysis Process Dow Stade GmbH. W91-11118 5D  High-Pressure Dewatering with Polymer Conditioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D Control of Enteric Micro-organisms by Aerobic-Thermophilic Co-Composting of Wastewater Sludge and Agro-Industry Sludge. W91-10693 5E New Developments in Processing of Sludges and Slurries.	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Technical Requirements and Possibilities of Incineration. W91-11129 5D  Environmental Aspects of Sludge Incineration: Overview. W91-11130 5E  Sewage Sludge Incineration and Utilization of Energy. W91-11131 5D  Sludge Treatment in Amsterdam: Economical, Technical and Environmental Experiences. W91-11132 5D  Status Report on Environment Canada's Oil
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge. W91-11116 5D  Sludge Reduction Possibilities as Demonstrated by the Chemolysis Process Dow Stade GmbH. W91-11118 5D  High-Pressure Dewatering with Polymer Conditioning as a Prerequisite for the Energy-Inde-	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D Control of Enteric Micro-organisms by Aerobic-Thermophilic Co-Composting of Wastewater Sludge and Agro-Industry Sludge. W91-10693 5E New Developments in Processing of Sludges	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Technical Requirements and Possibilities of Incineration. W91-11129 5D  Environmental Aspects of Sludge Incineration: Overview. W91-11130 5E  Sewage Sludge Incineration and Utilization of Energy. W91-11131 5D  Sludge Treatment in Amsterdam: Economical, Technical and Environmental Experiences. W91-11132 5D  Status Report on Environment Canada's Oil From Sludge Technology.
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge. W91-11116 5D  Sludge Reduction Possibilities as Demonstrated by the Chemolysis Process Dow Stade GmbH. W91-11118 5D  High-Pressure Dewatering with Polymer Conditioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge. W91-11127 5D	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D Control of Enteric Micro-organisms by Aerobic-Thermophilic Co-Composting of Wastewater Sludge and Agro-Industry Sludge. W91-10693 5E New Developments in Processing of Sludges and Slurries. W91-10699 5D	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Technical Requirements and Possibilities of Incineration. W91-11129 5D  Environmental Aspects of Sludge Incineration: Overview. W91-11130 5E  Sewage Sludge Incineration and Utilization of Energy. W91-11131 5D  Sludge Treatment in Amsterdam: Economical, Technical and Environmental Experiences. W91-11132 5D  Status Report on Environment Canada's Oil
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge. W91-11116 5D  Sludge Reduction Possibilities as Demonstrated by the Chemolysis Process Dow Stade GmbH. W91-11118 5D  High-Pressure Dewatering with Polymer Conditioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge. W91-11127 5D  Sludge Dewatering Technology in Perspective.	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D Control of Enteric Micro-organisms by Aerobic-Thermophilic Co-Composting of Wastewater Sludge and Agro-Industry Sludge. W91-10693 5E New Developments in Processing of Sludges and Slurries. W91-10699 5D Influence of Polyelectrolyte Characteristics on	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Technical Requirements and Possibilities of Incineration. W91-11129 5D  Environmental Aspects of Sludge Incineration: Overview. W91-11130 5E  Sewage Sludge Incineration and Utilization of Energy. W91-11131 5D  Sludge Treatment in Amsterdam: Economical, Technical and Environmental Experiences. W91-11132 5D  Status Report on Environment Canada's Oil From Sludge Technology.
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge. W91-11116 5D  Sludge Reduction Possibilities as Demonstrated by the Chemolysis Process Dow Stade GmbH. W91-11118 5D  High-Pressure Dewatering with Polymer Conditioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge. W91-11127 5D	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D Control of Enteric Micro-organisms by Aerobic-Thermophilic Co-Composting of Wastewater Sludge and Agro-Industry Sludge. W91-10693 5E New Developments in Processing of Sludges and Slurries. W91-10699 5D Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations).	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Technical Requirements and Possibilities of Incineration. W91-11129 5D  Environmental Aspects of Sludge Incineration: Overview. W91-11130 5E  Sewage Sludge Incineration and Utilization of Energy. W91-11131 5D  Sludge Treatment in Amsterdam: Economical, Technical and Environmental Experiences. W91-11132 5D  Status Report on Environment Canada's Oil From Sludge Technology. W91-11133 5D
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge. W91-11116 5D  Sludge Reduction Possibilities as Demonstrated by the Chemolysis Process Dow Stade GmbH. W91-11118 5D  High-Pressure Dewatering with Polymer Conditioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge. W91-11127 5D  Sludge Dewatering Technology in Perspective.	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D Control of Enteric Micro-organisms by Aerobic-Thermophilic Co-Composting of Wastewater Sludge and Agro-Industry Sludge. W91-10693 5E New Developments in Processing of Sludges and Slurries. W91-10699 5D Influence of Polyelectrolyte Characteristics on	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge. W91-11127 5D Sludge Dewatering Technology in Perspective. W91-11128 5D Technical Requirements and Possibilities of Incineration. W91-11129 5D Environmental Aspects of Sludge Incineration: Overview. W91-11130 5E Sewage Sludge Incineration and Utilization of Energy. W91-11131 5D Sludge Treatment in Amsterdam: Economical, Technical and Environmental Experiences. W91-11132 5D Status Report on Environment Canada's Oil From Sludge Technology. W91-11133 5D Thermophilic Aerobic Stabilisation. W91-11134 5D
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge. W91-11116 5D  Sludge Reduction Possibilities as Demonstrated by the Chemolysis Process Dow Stade GmbH. W91-11118 5D  High-Pressure Dewatering with Polymer Conditioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge. W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D Control of Enteric Micro-organisms by Aerobic-Thermophilic Co-Composting of Wastewater Sludge and Agro-Industry Sludge. W91-10693 5E New Developments in Processing of Sludges and Slurries. W91-10699 5D Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations).	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Technical Requirements and Possibilities of Incineration. W91-11129 5D  Environmental Aspects of Sludge Incineration: Overview. W91-11130 5E  Sewage Sludge Incineration and Utilization of Energy. W91-11131 5D  Sludge Treatment in Amsterdam: Economical, Technical and Environmental Experiences. W91-11132 5D  Status Report on Environment Canada's Oil From Sludge Technology. W91-11133 5D  Thermophilic Aerobic Stabilisation. W91-11134 5D  Influences on the Mechanical Properties of
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge. W91-11116 5D  Sludge Reduction Possibilities as Demonstrated by the Chemolysis Process Dow Stade GmbH. W91-11118 5D  High-Pressure Dewatering with Polymer Conditioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge. W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Sludge Treatment in Amsterdam: Economical,	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D Control of Enteric Micro-organisms by Aerobic-Thermophilic Co-Composting of Wastewater Sludge and Agro-Industry Sludge. W91-10693 5E New Developments in Processing of Sludges and Slutries. W91-10699 5D Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations).	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127  SD  Sludge Dewatering Technology in Perspective. W91-11128  Technical Requirements and Possibilities of Incineration. W91-11129  Environmental Aspects of Sludge Incineration: Overview. W91-11130  SE  Sewage Sludge Incineration and Utilization of Energy. W91-11131  SD  Sludge Treatment in Amsterdam: Economical, Technical and Environmental Experiences. W91-11132  SD  Status Report on Environment Canada's Oil From Sludge Technology. W91-11133  SD  Thermophilic Aerobic Stabilisation. W91-11134  SD  Influences on the Mechanical Properties of Sewage Sludge for Disposal to Landfill.
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge. W91-11116 5D  Sludge Reduction Possibilities as Demonstrated by the Chemolysis Process Dow Stade GmbH. W91-11118 5D  High-Pressure Dewatering with Polymer Conditioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge. W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Sludge Treatment in Amsterdam: Economical, Technical and Environmental Experiences. W91-11132 5D	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D Control of Enteric Micro-organisms by Aerobic-Thermophilic Co-Composting of Wastewater Sludge and Agro-Industry Sludge. W91-10693 5E New Developments in Processing of Sludges and Slurries. W91-10699 5D Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D CHP-Filter Press-The First Continuous High-	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Technical Requirements and Possibilities of Incineration. W91-11129 5D  Environmental Aspects of Sludge Incineration: Overview. W91-11130 5E  Sewage Sludge Incineration and Utilization of Energy. W91-11131 5D  Sludge Treatment in Amsterdam: Economical, Technical and Environmental Experiences. W91-11132 5D  Status Report on Environment Canada's Oil From Sludge Technology. W91-11133 5D  Thermophilic Aerobic Stabilisation. W91-11134 5D  Influences on the Mechanical Properties of
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge. W91-11116 5D  Sludge Reduction Possibilities as Demonstrated by the Chemolysis Process Dow Stade GmbH. W91-11118 5D  High-Pressure Dewatering with Polymer Conditioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge. W91-11128 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Sludge Treatment in Amsterdam: Economical, Technical and Environmental Experiences. W91-11132 5D  Sludge Treatment and Tipping Site 'Hartel-	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D Control of Enteric Micro-organisms by Aerobic-Thermophilic Co-Composting of Wastewater Sludge and Agro-Industry Sludge. W91-10693 5E New Developments in Processing of Sludges and Slurries. W91-10699 5D Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D CHP-Filter Press-The First Continuous High-Pressure Filter Press.	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127  SD  Sludge Dewatering Technology in Perspective. W91-11128  Technical Requirements and Possibilities of Incineration. W91-11129  Environmental Aspects of Sludge Incineration: Overview. W91-11130  SE  Sewage Sludge Incineration and Utilization of Energy. W91-11131  SD  Sludge Treatment in Amsterdam: Economical, Technical and Environmental Experiences. W91-11132  SD  Status Report on Environment Canada's Oil From Sludge Technology. W91-11133  Thermophilic Aerobic Stabilisation. W91-11134  SD  Influences on the Mechanical Properties of Sewage Sludge for Disposal to Landfill. W91-11135  SD
W91-10700 5D  Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D  CHP-Filter Press.—The First Continuous High-Pressure Filter Press. W91-10702 5D  Sewage Sludge Treatment and Use: New Developments, Technological Aspects and Environmental Effects. W91-11115 5E  Production, Treatment and Handling of Sewage Sludge. W91-11116 5D  Sludge Reduction Possibilities as Demonstrated by the Chemolysis Process Dow Stade GmbH. W91-11118 5D  High-Pressure Dewatering with Polymer Conditioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge. W91-11127 5D  Sludge Dewatering Technology in Perspective. W91-11128 5D  Sludge Treatment in Amsterdam: Economical, Technical and Environmental Experiences. W91-11132 5D	Sludge Dewatering Technology in Perspective. W91-11128 5D Chemolysis Process of Dow Stade GMBH. W91-11144 5D SLUDGE TREATMENT Clostridium perfringens, as an Indicator Microorganism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophilic Digestion. W91-10688 5D Control of Enteric Micro-organisms by Aerobic-Thermophilic Co-Composting of Wastewater Sludge and Agro-Industry Sludge. W91-10693 5E New Developments in Processing of Sludges and Slurries. W91-10699 5D Influence of Polyelectrolyte Characteristics on Sludge Conditioning (Lab Evaluations). W91-10701 5D CHP-Filter PressThe First Continuous High-Pressure Filter Press.	tioning as a Prerequisite for the Energy-Independent Incineration of Sewage Sludge.  W91-11127  SD  Sludge Dewatering Technology in Perspective. W91-11128  Technical Requirements and Possibilities of Incineration. W91-11129  Environmental Aspects of Sludge Incineration: Overview. W91-11130  SE  Sewage Sludge Incineration and Utilization of Energy. W91-11131  SD  Sludge Treatment in Amsterdam: Economical, Technical and Environmental Experiences. W91-11132  SD  Status Report on Environment Canada's Oil From Sludge Technology. W91-11133  Thermophilic Aerobic Stabilisation. W91-11134  SD  Influences on the Mechanical Properties of Sewage Sludge for Disposal to Landfill.

Sludge Recycling in Agriculture Compared with Other Disposal Methods in France.	Modern Sludge Management: The Manager's Choice.	Freshwater Snail, Pila globosa, and the Mussel, Lamellidens marginalis.
W91-11137 5E	W91-11122 5D	W91-11304 5C
Use of Municipal Sewage Sludge in Agriculture: The Role of the Water Authorities.	Status Report on Environment Canada's Oil From Sludge Technology.	SNOW Vapor Diffusional Growth of Free-Falling
W91-11138 5D	W91-11133 5D	Snow Crystals Between -3 and -23 C.
Sludge Treatment and Tipping Site 'Hartel-	Influences on the Mechanical Properties of	W91-10515 2C
mond'. W91-11140 5D	Sewage Sludge for Disposal to Landfill. W91-11135 5D	Observation of the Liquid Water Content of Melting Snowflakes with a New Instrument.
Stabilization of Sewage Sludge and Its Disinfec-	Sludge Recycling in Agriculture Compared with	W91-10516 2C
tion According to Specific Requirements: Two-	Other Disposal Methods in France. W91-11137 5E	Cloud/Cryosphere Interactions.
Stage Anaerobic/Aerobic Operating Techniques.	Use of Municipal Sewage Sludge in Agriculture:	W91-11095 2B
W91-11141 5D	The Role of the Water Authorities. W91-11138 5D	Executive Summary-Assessing the Response of Emerald Lake, An Alpine Watershed in Sequoia
Ban on Phosphorus in Detergents: The Effects on the Phosphorus Contents of Swiss Sewage	Examples of Agricultural Use of Residual	National Park, California, to Acidification During Snowmelt Using a Simple Hydrochemi-
Sludges and on the Efficiency of Phosphorus	Sludge.	cal Model.
Elimination by Sewage Treatment Plants. W91-11142 5D	W91-11139 5D	W91-11112 7C
Aerobic-Thermophilic Methods for Disinfecting	Composting Raw Sewage Sludge in the Absence of Bulking Agents.	Snow and Ice Perturbation during Historical Volcanic Eruptions and the Formation of
and Stabilizing Sludge. W91-11143 5D	W91-11149 5E	Lahars and Floods. W91-11394 2C
	Use of Sewage Sludge on Agricultural Land:	
Chemolysis Process of Dow Stade GMBH. W91-11144 5D	Impact on Soil Fauna. W91-11150 5E	SNOW COVER  Effects of Climate Change on Discharges and
Extraction of Heavy Metals from Sludges and	Existing Conditions for Agricultural Utilization	Snow Cover in Finland. W91-10964 2C
Muds by Magnetic Ion-Exchange.	of Sewage Sludge Compost in Japan. W91-11152 5E	
	Production of Compost from Sewage Sludge in	Satellite-Derived Reflectance of Snow-Covered Surfaces in Northern Minnesota.
Wet Oxydation as the Alternative for Sewage Sludge Treatment.	Tokyo.	W91-11353 7C
W91-11146 5D	W91-11153 5E	SNOWFALL
Heavy Metal Speciation in Sewage Sludge Fol- lowing a Phyto-Dewatering Treatment.	Beneficial Utilization of Incinerated Ash and Melted Slag.	Vapor Diffusional Growth of Free-Falling Snow Crystals Between -3 and -23 C.
W91-11147 5D	W91-11154 5E	W91-10515 2C
Production of Compost from Sewage Sludge in	Sludge Studies on Sludge Management: Strate- gic Studies on Sludge.	SNOWFLAKES Observation of the Liquid Water Content of
Tokyo. W91-11153 5E	W91-11156 5D	Melting Snowflakes with a New Instrument.
Beneficial Utilization of Incinerated Ash and	New Developments in Sampling Sludge Treated Soils.	W91-10516 2C
Melted Slag.	W91-11158 5A	SNOWMELT Comparison of Measured and Estimated Unsatu-
W91-11154 5E	Chemical Properties of Sewage Sludges Pro-	rated Hydraulic Conductivities During Snow- melt.
Sludge Dewatering: First Membrane Filterpress Plant in the Netherlands Operational.	duced in the Valencian Area (Spain). W91-11159 5A	W91-10904 2G
W91-11155 5D	Microbial Biomass and Biological Activities in	Self-Affine Scaling and Subsurface Response to
Sludge Studies on Sludge Management: Strate-	an Acid Sandy Soil Treated with Sewage Sludge or Farmyard Manure in a Long Term Field	Snowmelt in Steep Terrain. W91-10912 2G
gic Studies on Sludge. W91-11156 5D	Experiment.	Dynamic-Stochastic Models of Rainfall and
Studies for a Simultaneous Use of Liquid	W91-11160 5E	Snowmelt Runoff Formation.
Manure and Sewage Sludge. W91-11157 5E	Slurry and Sludge Spreading Methods. W91-11161 5E	W91-10967 2A
Treatment Technologies for Organochlorine-	Nitrogen Dynamics of Pulp and Paper Sludge	Variation of the Stable Isotopes of Water with Altitude in the Saint Elias Mountains of Canada.
Containing Sludges and Concentrates from Ex-	Amendment to Forest Soils. W91-11510 5E	W91-11220 2C
ternal Treatment of Pulp and Paper Wastewaters.		Assessing the Response of Emerald Lake, an
W91-11500 5D	New Developments in Processing of Sludges	Alpine Watershed in Sequoia National Park, California, to Acidification during Snowmelt by
Thermocatalytic and Chemical Treatment of Lignin-Aluminium Sludge and Utilization of the	and Slurries. W91-10699 5D	Using a Simple Hydrochemical Model. W91-11594 5C
Resulting Adsorbent-Coagulant. W91-11503 5D	Dutch Approach to Manure Processing. W91-10703 5D	SOCIAL ASPECTS
SLUDGE UTILIZATION	Slurry and Sludge Spreading Methods.	Socio-Economic Considerations in Remedial Action Planning for the Great Lakes-A Case
Processing Organic Waste Products to Black	W91-11161 5E	Study for Sustainable Development. W91-11031 6A
Soil and Organic Fertilizers. W91-10705 5E	SMITH CREEK VALLEY	Water Management in the 21st Century.
Sludge Management by Thermal Conversion to	Geochemical Evolution of Ground Water in Smith Creek Valley-A Hydrologically Closed	W91-11206 4A
Fuels. W91-10706 5D	Basin in Central Nevada, U.S.A. W91-11392 2K.	SODIUM CARBONATE
	SNAILS	Mathematical Modelling for Sulphur Dioxide Removal from Stack Gases in a Fluidized Bed of
Alternative Uses of Sludge Other than Agricul- tural.	Assessment of Mercury Toxicity by the Changes	Activated Sodium Carbonate.
W91-11120 5E	in Oxygen Consumption and Ion Levels in the	W91-11080 5G

## SOIL AERATION

SOIL AERATION Soil Clean Up by In-situ Aeration: VI. Effects of	or Farmyard Manure in a Long Term Field Experiment.	Theoretical Study of the Significance of None- quilibrium Dissolution of Nonaqueous Phase
Variable Permeabilities. W91-11317 5G	W91-11160 5E	Liquids in Subsurface Systems. W91-11228 5B
	Studies on the Effects of Some Organic Pollut-	
Processing Organic Waste Products to Black	ants on the Heavy Metal Transport in an Indian Soil.	SOIL DYNAMICS  Effect of Low Salinity Water on Salt Displace-
Soil and Organic Fertilizers.	W91-11457 5C	ment in Two Soils.
W91-10705 5E	SOIL COMPACTION	W91-11433 2G
Alternative Uses of Sludge Other than Agricul-	Deep-Seated Consolidation Settlements in the	SOIL ENGINEERING
tural.	Fraser River Delta.	Comparison of Field Consolidation with Labora-
W91-11120 5E	W91-10948 8D	tory and In Situ Tests.
Organic Substances in Soils and Plants after	SOIL CONSERVATION	W91-10781 8D
Intensive Applications of Sewage Sludge.	Soil Conservation Service and Extension: Coop-	Numerical Modelling of Vertical Ground Move-
W91-11126 5E	erating to Enhance Services (MES Portion). W91-11170 6E	ments in Expansive Soils.
Modifications of Some Physical Properties in		W91-10945 2G
Two Compost-Amended Italian Soils. W91-11148 5E	Coordinating Roles and Services: Soil Conserva-	SOIL EROSION
W91-11148 5E	tion Service and Extension Service. W91-11171 6E	RUSLE: Revised Universal Soil Loss Equation.
Studies for a Simultaneous Use of Liquid		W91-10510 2J
Manure and Sewage Sludge. W91-11157 5E	Soil and Moisture Conservation Technologies: Review of Literature.	WEPP: A New Generation of Erosion Predic-
W91-11137	W91-11565 4D	tion Technology.
Chemical Properties of Sewage Sludges Pro-		W91-10511 2J
duced in the Valencian Area (Spain). W91-11159 5A	Economic Analysis of Soil Conservation Tech- nologies.	WEPP: Soil Erodibility Experiments for Range-
	W91-11566 4D	land and Cropland Soils.
Microbial Biomass and Biological Activities in	P	W91-10512 2J
an Acid Sandy Soil Treated with Sewage Sludge or Farmyard Manure in a Long Term Field	Economic Analysis of Off-Farm Soil Conserva- tion Structures.	Spatial and Temporal Influence of Soil Frost on
Experiment.	W91-11567 4D	Infiltration and Erosion of Sagebrush Range-
W91-11160 5E		lands.
Slurry and Sludge Spreading Methods.	Revegetation Technologies. W91-11568 4D	W91-10820 2G
W91-11161 5E		Use of 137Cs as a Tracer in an Erosion Study in
I have Station of Minn Special Davis	SOIL CONTAMINATION	South Limburg (The Netherlands) and the Influ-
Laboratory Studies of Virus Survival During Aerobic and Anaerobic Digestion of Sewage	Treatability of Hazardous Chemicals in Soils: Volatile and Semivolatile Organics.	ence of Chernobyl Fallout. W91-11351 7B
Sludge.	W91-10712 5B	W91-11331 /B
W91-11319 5D	Superfund Record of Decision: Pesses Chemical,	Economic Analysis of Soil Conservation Tech-
Nitrogen Dynamics of Pulp and Paper Sludge	TX.	nologies. W91-11566 4D
Amendment to Forest Soils.	W91-10718 5G	W91-11300 4D
W91-11510 5E	Soil Vapor Survey at the LLNL Site 300 Gener-	SOIL HORIZONS
SOIL ANALYSIS	al Services Area, Adjacent Portions of the Con-	Kinetics of Chemical Weathering in B Horizon Spodosol Fraction.
Field Sampling of Residual Aviation Gasoline in	nolly and Gallo Ranches and the Site 300 Land-	W91-11233 5C
Sandy Soil. W91-10795 5A	fill Pit 6 Area. W91-10747 5B	CONT. MANAGEMENT
W91-10/93	W91-10/4/	SOIL MANAGEMENT Soil Clean Up by In-situ Aeration: VI. Effects of
Studies on the Environmental Persistence of S-	Mechanistic Evaluation of Mitigation of Petrole-	Variable Permeabilities.
31183 (Pyriproxyfen): Adsorption onto Organic Matter and Potential for Leaching through Soil.	um Hydrocarbon Contamination by Soil Medium.	W91-11317 5G
W91-10831 5B	W91-10779 5G	SOIL MECHANICS
Multimethod for Pesticides in Soil at Trace	Field Sampling of Positival Assisting Cospling in	Change in Pore Size Distribution Owing to Sec-
Level.	Field Sampling of Residual Aviation Gasoline in Sandy Soil.	ondary Consolidation of Clays.
W91-11309 5A	W91-10795 5A	W91-10774 8D
Determination of Herbicide Residues in Soil in	Aqueous Surfactant Washing of Residual Oil	Analysis of Three-Dimensional Ground Move-
the Presence of Persistent Organochlorine Insec-	Contamination from Sandy Soil.	ments: The Thunder Bay Tunnel.
ticides.	W91-10796 5G	W91-10775 8A
W91-11310 5A	Method for Assessing Residual NAPL Based on	Finite-Element Analysis of Softening Effects in
Simple Spectrophotometric Determination of	Organic Chemical Concentrations in Soil Sam-	Fissured, Overconsolidated Clays and Mud-
Endosulfan in River Water and Soil.	ples.	stones. W91-10776 8D
W91-11314 5A	W91-10797 5A	W91-10776 8D
SOIL BACTERIA	Studies on the Environmental Persistence of S-	Electroosmotic Strengthening of Soft Sensitive
Dispersal Dynamics of Groundwater Bacteria. W91-10843	31183 (Pyriproxyfen): Adsorption onto Organic Matter and Potential for Leaching through Soil.	Clays. W91-10777 8D
W91-10843 5B	W91-10831 5B	
Denitrification by Thermophilic Soil Bacteria		Field Test of Electroosmotic Strengthening of
With Ethanol as Substrate in a USB Reactor. W91-11254 5D	Transformation of (C-14)-2,4-Dichlorophenol in Saskatchewan Soils.	Soft Sensitive Clay. W91-10778 8D
	W91-10922 5B	
SOIL CHEMISTRY		Mechanistic Evaluation of Mitigation of Petrole-
Effects of Sewage Sludge and Waste Compost on Some Soil Enzymatic Activities Tested in a	Organic Substances in Soils and Plants after Intensive Applications of Sewage Sludge.	um Hydrocarbon Contamination by Soil Medium.
Field Experiment.	W91-11126 5E	W91-10779 5G
W91-11151 5E		Analysis of a Sanitary-Embankment Failure
Microbial Biomass and Biological Activities in	Environmental Aspects of Sludge Incineration: Overview.	Over the Rio de Janeiro Soft Clay Deposit.
an Acid Sandy Soil Treated with Sewage Sludge	W91-11130 5E	W91-10780 8D

Comparison of Field Consolidation with Labora-	SOIL STRENGTH	Comparison of Measured and Estimated Unsatu-
tory and In Situ Tests.	Finite-Element Analysis of Softening Effects in	rated Hydraulic Conductivities During Snow-
W91-10781 8D	Fissured, Overconsolidated Clays and Mud-	melt.
COLL OBCANIC MATTER	stones.	W91-10904 2G
SOIL ORGANIC MATTER	W91-10776 8D	
Can Fauna Impoverishment Affect Humus Con-		Soil Water Dynamics Related to Waterlogging
tent in Cultivated Soils (Czy ubozenie fauny	Field Test of Electroosmotic Strengthening of	in a Sloping Catchment.
moze wplywac na zawartosc prochnicy w gle-	Soft Sensitive Clay.	W91-10906 2G
bach uprawnych).	W91-10778 8D	
W91-11543 2G	COTT CERTIFIED	Sorption Properties and Moisture Hysteresis of
SOIL ORGANISMS	SOIL STRUCTURE	Soils.
	Change in Pore Size Distribution Owing to Sec-	W91-10916 2G
Use of Sewage Sludge on Agricultural Land: Impact on Soil Fauna.	ondary Consolidation of Clays.	
W91-11150 5E	W91-10774 8D	Numerical Modelling of Vertical Ground Move-
W91-11130 3E	SOIL SURVEY INFORMATION SYSTEM	ments in Expansive Soils.
Can Fauna Impoverishment Affect Humus Con-		W91-10945 2G
tent in Cultivated Soils (Czy ubozenie fauny	Soil Survey Information System: A User Friend-	
moze wplywac na zawartosc prochnicy w gle-	ly Soil Information System.	Dynamic Simulation Model of Vertical Infiltra-
bach uprawnych).	W91-11174 7C	tion of Water in Soil.
W91-11543 2G	SOIL SURVEYS	W91-10968 2A
***************************************	Soil Survey Information System: A User Friend-	
SOIL PHYSICAL PROPERTIES	ly Soil Information System.	Throughflow and Solute Transport in an Isolat-
Modifications of Some Physical Properties in	W91-11174 7C	ed Sloping Soil Block in a Forested Catchment.
Two Compost-Amended Italian Soils.	W91-111/4 /C	W91-10993 2G
W91-11148 5E	SOIL TEXTURE	
	Calibration of a Texture-Based Model of a	Hydrologic, Meteorological, and Unsaturated-
Use of Sewage Sludge on Agricultural Land:	Ground-Water Flow System, Western San Joa-	Zone Moisture-Content Data, Franking Lake
Impact on Soil Fauna.	quin Valley, California.	Playa, Inyo County, California.
W91-11150 5E		W91-11089 2F
SOIL PIPING	SOIL TREATMENT	Improved Analysis of Gravity Drainage Experi-
Piping and Pseudokarst in Drylands.	Mechanistic Evaluation of Mitigation of Petrole-	ments for Estimating Unsaturated Soil Hydraulic
W91-11561 2F	um Hydrocarbon Contamination by Soil	Functions.
***	Medium.	W91-11237 2G
SOIL POROSITY	W91-10779 5G	
Modelling Water and Solute Transport in Ma-	W 91-10/19	Hydrological Consequences of Artificial Drain-
croporous Soil. I. Model Description and Sensi-	Aqueous Surfactant Washing of Residual Oil	age of Grassland.
tivity Analysis.	Contamination from Sandy Soil.	W91-11347 2G
W91-10803 5B	W91-10796 5G	
M 1 W W 1 W 1 O 1 O 1 O T 1 O 1 O 1 O 1 O 1 O 1 O 1	W71-10/70	Soil Moisture: Empirical Data and Model Re-
Modelling Water and Solute Transport in Ma- croporous Soil. II. Chloride Breakthrough	SOIL TYPES	sults.
	Permeability of Soils with Organic Fluids.	W9i-11413 2G
Under Non-Steady Flow.	W91-10783 5B	
W91-10804 2G		Solution in Closed Form and a Series Solution to
SOIL PRESSURE	Causes of Degradation of Chemical and Physical	Replace the Tables for the Thickness of the
Pressure of Clay Backfill against Retaining	Properties of Chernozems Irrigated with Non-	Equivalent Layer in Hooghoudt's Drain Spacing
Structures.	mineralized Water.	Formula.
W91-10947 8D	W91-10913 2G	W91-11430 2G
W 91-10947 0D		
SOIL PROPERTIES	Effect of Long-Term Application of Fertilizers	Soil and Moisture Conservation Technologies
Finite-Element Analysis of Softening Effects in	on the Agrophysical Properties of an Irrigated	Review of Literature.
Fissured, Overconsolidated Clays and Mud-	Light-Chestnut Soil.	W91-11565 4D
stones.	W91-10914 2G	
W91-10776 8D		SOIL-WATER-PLANT RELATIONSHIPS
#71-10770	Physical Properties of Irrigated Chernozems of	Ozone, Acidic Precipitation, and Soil Mg Ef
Comparison of Field Consolidation with Labora-	the Southern Ukraine.	fects on Growth and Nutrition of Loblolly Pine
tory and In Situ Tests.	W91-10915 2G	Seedlings.
W91-10781 8D	CON HARDS	W91-10918 50
	SOIL VAPOR	
Permeability of Soils with Organic Fluids.	Soil Vapor Survey at the LLNL Site 300 Gener-	Hydrological Balance of Two Mediterranean
W91-10783 5B	al Services Area, Adjacent Portions of the Con-	Forested Catchments (Prades, Northeast Spain)
	nolly and Gallo Ranches and the Site 300 Land-	W91-10963 2A
Causes of Degradation of Chemical and Physical	fill Pit 6 Area.	
Properties of Chernozems Irrigated with Non-	W91-10747 5B	Effect of Land Development on Groundwate
mineralized Water.	CON WATER	Recharge Determined from Non-Steady Chlo
W91-10913 2G	SOIL WATER	ride Profiles.
	Modelling Water and Solute Transport in Ma-	W91-10991 40
Physical Properties of Irrigated Chernozems of	croporous Soil. I. Model Description and Sensi-	
the Southern Ukraine.	tivity Analysis.	SOILS
W91-10915 2G	W91-10803 5B	Secondary Salinization of Soils of the Dnieste
Sorption Properties and Moisture Hysteresis of	Modelling Water and Solute Transport in Ma-	Delta Floodplain.
	croporous Soil. II. Chloride Breakthrough	W91-10917 20
Soils.	Under Non-Steady Flow.	
W91-10916 2G	W91-10804 2G	SOLID WASTE DISPOSAL
SOIL SAMPLING	W 71-10004 2G	Evaporative Drying of Dredged Material.
New Developments in Sampling Sludge Treated	Simple Design for Simultaneous Steady-State In-	W91-11000 5I
Soils.	filtration Experiments with Ring Infiltrometers.	
	W91-10813 7B	Returnable Pesticide Containers: Maine's Depos
W91-11158 5A	W. 71-10013	it and Collection System.
SOIL STABILIZATION	Spatial and Temporal Influence of Soil Frost on	W91-11191 50
Comparison of Field Consolidation with Labora-	Infiltration and Erosion of Sagebrush Range-	
tory and In Situ Tests.	lands.	Oregon Pesticide Container Initiative.
W91-10781 8D	W91-10820 2G	W91-11192 51

#### SOLUTE TRANSPORT

SOLUTE TRANSPORT Ground-Water Flow and Solute Movement to	Sorption Properties and Moisture Hysteresis of Soils.	Effect of Hydroelectric Stations on Water Qual- ity and Development of Phytoplankton in the
Drain Laterals, Western San Joaquin Valley,	W91-10916 2G	Lower Pools of Reservoirs.
California. I. Geochemical Assessment. W91-10768 5B	Preconcentration of Hydrophilic and Hydropho-	W91-11289 6G
Ground-Water Flow and Solute Movement to	bic Pesticides from Aqueous Solutions and Ex- traction of Residues Using the Polymeric Sor-	Operating Experience and Suggestions on Re- construction of the Turbines of the Dnepr-I Hy-
Drain Laterals, Western San Joaquin Valley, California. II. Quantitative Hydrologic Assess-	bent Wofatit Y 77. W91-11305 5A	droelectric Station.
ment.		
W91-10769 5B	Lead Sorption in Calcareous Soils. W91-11453 5B	First Steps Toward Increasing the Reliability of Hydropower and Water-Management Facilities.
Impact of Recharge Through Residual Oil Upon Sampling of Underlying Ground Water.	Treatment of Bleach-Plant Effluents with Mem-	W91-11291 8A
W91-10793 5B	brane Filtration and Sorption Techniques. W91-11489 5D	Distribution and Migration of Heavy Metals in the Environment of the Altai Mountains in Con-
Modelling Water and Solute Transport in Ma- croporous Soil. I. Model Description and Sensi-	Fate and Transport of Sediment-Associated	nection with Ecological Substantiation of the Katun Hydroelectric Station Project.
tivity Analysis.	Contaminants. W91-11587 5B	W91-11292 5B
W91-10803 5B	SOUTH AFRICA	Method of Compiling Water-Management Bal-
Modelling Water and Solute Transport in Ma- croporous Soil. II. Chloride Breakthrough	Occurrence of Legionella Bacteria in Cooling	ances. W91-11293 2A
Under Non-Steady Flow.	Towers in South Africa. W91-10641 5B	
W91-10804 2G	Detection of Rotavirus in South African Waters:	Stability of Hydropower Construction Programs.
Hydrogeochemical Processes Controlling Sub- surface Transport from an Upper Subcatchment	A Comparison of a Cytoimmunolabelling Tech-	W91-11294 8C
of Walker Branch Watershed During Storm	nique with Commercially Available Immunoas- says.	SPAIN
Events. 2. Solute Transport Processes. W91-10908 5B	W91-10660 5A	Man-Made Garbage Pollution on the Mediterra- nean Coastline.
	Occurrence of Male-Specific and Somatic Bac-	W91-10569 5B
Characteristics of Rhodamine WT and Fluores- cein as Adsorbing Ground-Water Tracers.	teriophages in Polluted South African Waters. W91-10662 5B	'Parque de Donana', and Its Contribution to
W91-10952 5B		Environmental Activities for Environmental
Geochemical Evolution in the Cambrian-Ordo-	Modification of Benthic Community Structure in Response to Acid-Iron Wastes Discharge.	Protection. W91-10586 5G
vician Sandstone Aquifer, Eastern Wisconsin: 1.  Major Ion and Radionuclide Distribution.	W91-10869 5C	Sediment Transport on the Foreshore.
W91-10953 2K	Impact of Titanium Dioxide Waste on Fertiliza-	W91-10599 2L
Delineation of a Discontinuous Aquitard with	tion in the Sea Urchin Echinometra mathaei. W91-10870 5C	Enumeration of Motile Aeromonas in Valencia
Vertical Electrical Soundings, San Bernardino Valley, Southern California.	SOUTH AMERICA	Coastal Waters by Membrane Filtration.
W91-10960 5B	Perspectives for Ecological Modelling of Tropi-	W91-10636 5B
Salinity and Evaporation in the River Murray	cal and Subtropical Reservoirs in South America.	Volatile Organic Compounds in Two Polluted Rivers in Barcelona (Catalonia, Spain).
Basin, Australia. W91-10989 2E	W91-10487 2H	W91-10887 5B
Throughflow and Solute Transport in an Isolat-	Managing Water Resources in Latin America.	Hydrological Balance of Two Mediterranean
ed Sloping Soil Block in a Forested Catchment.	W91-11385 6B	Forested Catchments (Prades, Northeast Spain). W91-10963 2A
W91-10993 2G	SOUTH CAROLINA Ground-Water Flow and Stream-Aquifer Rela-	
Boundary Element and Particle Tracking Model for Advective Transport in Zoned Aquifers.	tions in the Northern Coastal Plain of Georgia	Chemical Properties of Sewage Sludges Pro- duced in the Valencian Area (Spain).
W91-10997 2F	and Adjacent Parts of Alabama and South Caro- lina.	W91-11159 5A
Leaching of Ammonium Nitrate under Field	W91-11598 2F	Morphology and Quantitative Analysis of Fluvi-
Conditions: Studies on Kinetics of Nitrification and Nitrate Reduction in an Ultisol Profile.	SOUTH CHINA SEA	al Erosion Systems in the Hydrological Network of the Basque Country Autonomous Region.
W91-10999 5B	Long Term Ecological Changes in the Gulf of Thailand.	W91-11265 2J
Application of a Multiprocess Nonequilibrium	W91-10551 5B	SPATIAL DISTRIBUTION
Sorption Model to Solute Transport in a Strati-	SOUTH VALLEY SUPERFUND SITE	Spatial Distribution of Precipitation Seasonality in the United States.
fied Porous Medium. W91-11239 5B	Superfund Record of Decision: South Valley (PL-83), NM.	W91-11414 2E
SOLUTES	W91-10721 5G	SPATIAL VARIATION
Ground-Water Control of Evaporite Deposition.	Superfund Record of Decision: South Valley/	Paleohydrologic Techniques Used to Define the
W91-11438 2K	Edmunds Street, NM. W91-10758 5G	Spatial Occurrence of Floods. W91-11396 2E
SOLVENTS Utility of Multiple-Completion Monitoring		SPAWNING
Wells for Describing a Solvent Plume.	SOVIET UNION Hydraulicking in Environmental Protection and	Rise and Fall of the Potomac River Striped Base
W91-10800 7A	Restoration.	Stock: A Hypothesis of the Role of Sewage W91-11529
SONORAN DESERT	W91-11283 5G	
Assessment of the Salinity Tolerance of Eight Sonoran Desert Riparian Trees and Shrubs.	Method of Calculating the Technological Pa- rameters When Designing Hydraulic-Fill Dams	SPECIES COMPOSITION Changes and Stress Signs in Plankton Communi
W91-10752 3C	of Silty Soils.	ties as a Result of Man-Induced Perturbations is
SORPTION	W91-11284 8A	Enclosed Coastal Seas (Mediterranean, Baltic) W91-10547
Sorption Phenomena in Subsurface Systems: Concepts, Models, and Effects on Contaminant	Selection of the Operating Regime of the Onega- Svir' Water System Under Conditions of In-	Species Composition of Fish Communities in
Fate and Transport.	creasing Water Consumption.	Northern Wisconsin Lakes: Relation to pH.
W91-10882 5B	W91-11288 6D	W91-10725 50

6D

Pacific Salmon at the Crossroads: Stocks at Risk from California, Oregon, Idaho, and Washing- ton.	SPORT FISHING Estimation of Sport Fish Harvest for Risk and Hazard Assessment of Environmental Contami-	Dynamics of Non-01 Vibrio cholerae in Experi- mental Sewage Stabilization Ponds Under Arid Mediterranean Climate.
W91-10834 8I	nants.	W91-10690 5D
Microbial Mats in Tidal Channels at San Carlos,	W91-11556 5G	Waste Stabilization Ponds in Grand Cayman,
Baja California Sur, Mexico. W91-11400 2L	SPRAYING Contamination of Ponds by Fenitrothion during	Cayman Islands. W91-10691 5D
Analysis of Subfossil Shelled Protozoa in the	Forest Spraying.	
Sediments of a Small Acid Forest Lake (Kleiner	W91-11298 5B	Survival of Pathogenic Bacteria in an Adverse Environment.
Barsch-See, Northern GDR) (Analyse Subfos- siler Protozoenschalen der Sedimente eines	Transport of the Fungicide Chlorothalonil from Its Operational Use on a Pond Ecosystem.	W91-10692 5D
Kleinen Sauren Waldsees) (Kleiner Barsch-See, Nordliche DDR).	W91-11299 5B	STABLE ISOTOPES  Variation of the Stable Isotopes of Water with
W91-11516 2H	SPRINGS	Altitude in the Saint Elias Mountains of Canada.
Fish Fauna of Various Bodies of Stagnant Water	Geohydrologic Evaluation of Spring Sites at Social Circle, Georgia, December 5-8, 1988.	W91-11220 2C
Near Concepcion (Paraguay) (Zur Fischfauna Einiger Stehender Gewasser bei Concepcion	W91-10767 2F	STAGE-DISCHARGE RELATIONS Automatic Tracer-Dilution Method Used for
(Paraguay)). W91-11523 2H	Macrophyte Standing Crop and Primary Pro- ductivity in Some Florida Spring-Runs.	Stage-Discharge Ratings and Streamflow Hy-
Local and Seasonal Variation of the Epipelic	W91-10812 2E	drographs on Small Iowa Streams. W91-11111 7B
Algae in Samarra Impoundment, Iraq.	Contribution to the Study of the Recession	
W91-11525 2H	Curves of Karstic Springs: Examples from	STAGNANT WATER Fish Fauna of Various Bodies of Stagnant Water
SPECIES DIVERSITY	Greece (Contribution a l'Etude des Courses de Recession des Sources Karstiques: Exemples du	Near Concepcion (Paraguay) (Zur Fischfauna
Succession of Benthic Assemblages in Wild Bird	Pays Hellenique).	Einiger Stehender Gewasser bei Concepcion (Paraguay)).
Park, a Sanctuary Established on Reclaimed	W91-10990 2F	W91-11523 2H
W91-10606 2L	Studies of Springs in the Southern Part of the	STANDARDS
Species Composition of Fish Communities in	Valley of Mexico (Estudio Crenologico en la	Production and Control of Reference Materials
Northern Wisconsin Lakes: Relation to pH. W91-10725 5C	Parte Meridional de la Cuenca de Mexico). W91-11352 2E	for Water Microbiology. W91-10623 5A
	SQUALLS	
Aquatic Macroinvertebrates of the St. Francis Sunken Lands in Northeast Arkansas.	Electrical and Kinematic Structure of the Strati-	Ambient Water Quality Criteria for Ammonia
W91-10844 4C	form Precipitation Region Trailing an Oklahoma Squall Line.	(Saltwater)-1989. W91-10750 5G
Downstream Changes in Caddisfly Composition	W91-10514 2B	STANDING CROPS
and Abundance in Relation to Changes in Water	Squall Line in Southern Germany: Kinematics	Macrophyte Standing Crop and Primary Pro-
Conductivity and Oxygen in the River Butron Basin.	and Precipitation Formation as Deduced by Ad-	ductivity in Some Florida Spring-Runs. W91-10812 2E
W91-11403 5C	vanced Polarimetric and Doppler Radar Meas- urements.	
Assessment of Water Pollution using Diatom	W91-11420 2B	STAPHYLOCOCCUS  Staphylococci in Polluted Waters and in Waters
Community Structure and Species Distribution— A Case Study in a Tropical River Basin.	SQUAWFISH	of Uninhabited Areas.
W91-11404 5C	Distribution, Habitat Use, and Growth of Age-0 Colorado Squawfish in the Green River Basin,	W91-10631 5E
SPECTROPHOTOMETRY	Colorado and Utah.	STATE JURISDICTION
Spectrophotometric Determination of Nitrite in	W91-11534 2H	Oregon Pesticide Container Initiative. W91-11192 5E
Polluted Waters Using 3-Nitroaniline. W91-10823 5A	ST CROIX RIVER	
Simultaneous Ultraviolet Spectrophotometric	Monthly Mean Discharge at and Between Se- lected Streamflow-Gaging Stations Along the	Regulation of Interbasin Transfers and Con sumptive Uses from the Great Lakes.
Determination of Nitrate and Nitrite in Water.	Mississippi, Minnesota, and St. Croix Rivers,	W91-11384 6F
W91-10824 5A	1932-87.	Toxics Reduction: The Legal Framework.
Comparison of Amperometric and UV-Spectro-	W91-10760 2E	W91-11538 6l
photometric Monitoring in the HPLC Analysis of Pesticides.	ST JOHNS BAYOU	CTATIOTICAL ANALYCIC
W91-11306 5A	St. Johns Bayou Pumping Station, Missouri: Hydraulic Model Investigation.	STATISTICAL ANALYSIS Statistical Analysis of Errors in Estimating We
Simple Spectrophotometric Determination of	W01 11500 9C	Deposition Using Five Surface Estimation Algorithms.
Endosulfan in River Water and Soil.	ST LAWRENCE ESTUARY	W91-10474 71
W91-11314 5A	First-Order Organic Carbon Budget in the St	Balainatia Batana Man and Standard David
SPHAGNUM	Lawrence Lower Estuary from 13C Data. W91-10498 2L	Relationship Between Mean and Standard Dev- ation in Precipitation Chemistry Measurement
Impact of Carbon Dioxide and Ammonium on the Growth of Submerged Sphagnum cuspida-		Across Eastern North America.
tum.	ST LOUIS  Precipitation Changes in Fall, Winter, and	W91-10475 2
W91-11452 2H	Spring Caused by St Louis.	Preliminary Statistical Assessment of UK Water
SPILLWAYS	W91-10500 2B	Quality Control Trials. W91-10624 50
Scour at Cantilevered Pipe Outlets, Plunge, Pool Energy Dissipator Design Criteria.	ST VENANT EQUATION	
W91-10722 8B	Similarity Solutions of the Shallow Water Equa- tions.	Effects of Land-Use Buffer Size on Spearman Partial Correlations of Land Use and Shallon
Drag on Vertical Sill of Forced Jump.	W91-10987 8B	
W91-10985 8B	STABILIZATION PONDS	W91-10761 4
SPOIL DISPOSAL	Contribution for the Study of New Pathogenic	
Evaporative Drying of Dredged Material.	Indicators Removal from W. S. P. in Portugal.	flow Data Through September 30, 1988. W91-10770

## STATISTICAL ANALYSIS

Geostatistical Characteristics of the Borden Aq-	Streamflow Generation in a Headwater Basin on	and Their Resistance Patterns to Antibiotics and
uifer. W91-11234 2F	the Precambrian Shield. W91-11349 2E	Heavy Metal Salts. W91-10675 5B
STATISTICAL METHODS  Relationship Between Mean and Standard Devi-	STORM WASTEWATER Hydrocarbons in Urban Runoff: Their Contribu-	September 5, 1987, Landslide on the La Grande River, James Bay, Quebec, Canada.
ation in Precipitation Chemistry Measurements Across Eastern North America.	tion to the Wastewaters. W91-10885 5B	W91-10946 2J
W91-10475 2B		STREAM BIOTA
	STORM WATER MANAGEMENT	Studies on the Bacterial Fauna of the Tamagawa
LC-50 Estimates and Their Confidence Intervals Derived for Tests with Only One Concentration	New Storm Water Regulations Require Signifi- cant Compliance Actions by Both Industries and	River.
with Partial Effect.	Municipalities.	W91-10632 5B
W91-10930 5C	W91-11541 5D	Macrophyte Standing Crop and Primary Pro-
Usefulness of Various Numerical Methods for	STORMS	ductivity in Some Florida Spring-Runs.
Assessing the Specific Effects of Pollution on	Electrical and Kinematic Structure of the Strati-	W91-10812 2E
Aquatic Biota.	form Precipitation Region Trailing an Oklahoma	Regulatory Influence of Water Current on Algal
W91-11406 5C	Squall Line. W91-10514 2B	Colonization in an Unshaded Stream at Shillong
STATISTICAL MODELS	W91-10514 2B	(Meghalaya, India).
Estimation of the Mean Field Bias of Radar	Canadian Atlantic Storms Program: Progress	W91-11451 2E
Rainfall Estimates. W91-10857 2B	and Plans of the Meteorological Component. W91-10943 2B	Impact of a Pulse Application of Permethrin on
W91-10657	W91-10943	the Macroinvertebrate Community of a Head-
Techniques for Estimation of Storm-Runoff	Chemical Composition of Individual Storms as a	water Stream.
Loads, Volumes, and Selected Constituent Con- centrations in Urban Watersheds in the United	Function of Air Parcel Trajectories for the Pre- diction of Acid Rain Characteristics.	W91-11456 5C
States.	W91-11075 5B	Saprobiological Investigations on the Bottom
W91-11094 5B	Kinematic, Dynamic, and Thermodynamic	Flora of the River Recknitz in the Northern Part
STATISTICS	Analysis of a Weakly Sheared Severe Thunder-	of the Mecklenburgian Lake District (GDR) (Saprobiologische Untersuchungen an der
Estimation of the Mean Field Bias of Radar	storm over Northern Alabama.	Benthosflora der Recknitz im Norden der Meck-
Rainfall Estimates. W91-10857 2B	W91-11417 2B	lenburger Seenplatte (DDR)).
	Satellite-Derived Integrated Water-Vapor Dis-	W91-11520 2E
STOCHASTIC HYDROLOGY	tribution in Oceanic Midlatitude Storms: Varia-	Microzoobenthos of the River Jihlava After the
Modeling Lake Erie as a Stochastic Linear Res- ervoir.	tion with Region and Season. W91-11419 2B	Construction of the Dalesice Waterworks.
W91-11029 7C		W91-11521 6G
CONTRACTOR OF CO	Sensitivity Studies of Tropical Storm Genesis	Habitat Use by an Assemblage of Fish in a Large
STOCHASTIC MODELS  Dynamic-Stochastic Models of Rainfall and	Using a Numerical Model. W91-11421 2B	Warmwater Stream.
Snowmelt Runoff Formation. W91-10967 2A	Convective Cell in a Hurricane Rainband.	W91-11533 2H
W91-10907 2A	W91-11422 2B	Upstream Extirpation of Four Minnow Species
STOMATAL TRANSPIRATION	Dynamical Forcing and Mesoscale Organization	Due to Damming of a Prairie Stream.
Effects of Drought Stress and Simulated Acidic Rain on Foliar Conductance of Zea mays L.	of Precipitation Bands in a Midwest Winter Cy-	W91-11535 6G
W91-10919 5C	clonic Storm. W91-11424 2B	STREAM CLASSIFICATION
STORAGE RESERVOIRS		Fast Algorithm for Automatically Computing Strahler Stream Order.
Regional Approach to Salinity Management in	STRAIT OF GEORGIA	W91-10818 2J
River Basins. A Case Study in Southern Iran. W91-11432 5G	Strategies for Restoring and Developing Fish Habitats in the Strait of Georgia: Puget Sound	
W91-11432 5G	Inland Sea, Northeast Pacific Ocean.	STREAM DISCHARGE
STORM-OVERFLOW SEWERS	W91-10568 5G	Runoff Characteristics of COD, BOD, C, N, and P Loadings from Rivers to Enclosed Coastal
Dynamic Simulation of Storm Tanks. W91-10928 5D	STRATIGRAPHY	Seas.
	Correlated Oceanic and Continental Records	W91-10521 5B
STORM RUNOFF	Demonstrate Past Climate and Hydrology of	Outflow and Three-Dimensional Spreading of
Urban Storm-Induced Discharge Impacts. W91-10745 5B	North Africa (0-140 ka). W91-10788 2B	River Water in Enclosed Bay.
		W91-10525 2L
Techniques for Estimation of Storm-Runoff Loads, Volumes, and Selected Constituent Con-	Acoustic Parametric Array for Measuring the Thickness and Stratigraphy of Contaminated	Monthly Mean Discharge at and Between Se-
centrations in Urban Watersheds in the United	Sediments.	lected Streamflow-Gaging Stations Along the
States.	W91-10981 2J	Mississippi, Minnesota, and St. Croix Rivers,
W91-11094 5B	Diatom Analysis, Late-Glacial and Post-Glacial	1932-87.
New Storm Water Regulations Require Signifi-	Development of Lake Kleiner Barsch-See	W91-10760 2E
cant Compliance Actions by Both Industries and Municipalities.	(GDR)A Preliminary Note. W91-11517 2H	STREAM EROSION
W91-11541 5D		Morphology and Quantitative Analysis of Fluvi- al Erosion Systems in the Hydrological Network
	Chemical Composition of Late- and Post-Glacial	of the Basque Country Autonomous Region.
STORM SEEPAGE Hydrogeochemical Processes Controlling Sub-	Sediments (Fe, Mn, P, C, N, N, H and BSi) in Lake Kleiner Barsch-See, a Bog Lake in the	W91-11265 2J
surface Transport from an Upper Subcatchment	North of GDR (Die Chemische Zusammenset-	STREAM FISHERIES
of Walker Branch Watershed During Storm	zung der Spat- und Postglazialsedimente des	Distribution, Habitat Use, and Growth of Age-0
Events. 1. Hydrologic Transport Processes. W91-10907 5B	Kleinen Barsch-Sees (Fe, Mn, P, C, N, H und BSi), eines Dystrophen Moorweihers im Norden	Colorado Squawfish in the Green River Basin, Colorado and Utah.
Hydrogeochemical Processes Controlling Sub-	der DDR).	W91-11534 2H
surface Transport from an Upper Subcatchment	W91-11518 2H	
of Walker Branch Watershed During Storm	STREAM BANKS	Short-Term Effects of a Catastrophic Beaver
Events. 2. Solute Transport Processes. W91-10908 5B	Species and Genera of Enterobacteriaceae in River Neckar and After River Bank Filtration	Dam Collapse on a Stream Fish Community. W91-11558 2E
# 71-10900 3B	KIVEL NECKMI MIG ALICE KIVEL DHIR LIILLATION	1171-11330 ZE

Models of Seasonal Growth of the Equatorial	Comparison of Mean Annual Runoff Estimates	STRUCTURAL SETTLEMENT
Carp Labeo dussumieri in Response to the River Flood Cycle.	in the Canadian Portion of the Great Lakes Basin.	Deep-Seated Consolidation Settlements in the
W91-11559 2H	W91-11020 2E	Fraser River Delta. W91-10948 8D
Drift of the Characin Larvae, Bryconamericus	Effects of Changes in Land Use on Annual	SUBLETHAL EFFECTS
deuterodonoides, During the Dry Season from Andean Piedmont Streams. W91-11560 2H	Streamflows in the Lake Huron Basin of Canada and the United States. W91-11021 4C	Induction of Biotransformation in the Liver of Eel (Anguilla anguilla L.) by Sublethal Exposure
		to Dinitro-o-cresol: An Ultrastructural and Bio- chemical Study.
STREAM GAGING Automatic Tracer-Dilution Method Used for Stage-Discharge Ratings and Streamflow Hy-	Automatic Tracer-Dilution Method Used for Stage-Discharge Ratings and Streamflow Hy- drographs on Small Iowa Streams.	W91-10826 5C
drographs on Small Iowa Streams. W91-11111 7B	W9Ĭ-1Ì111 7B	SUBMERGED AQUATIC PLANTS Impact of Carbon Dioxide and Ammonium on
Knowledge-Based Systems and Operational Hy-	Aquatic Habitat Measurement and Valuation: Imputing Social Benefits to Instream Flow	the Growth of Submerged Sphagnum cuspida- tum.
drology.	Levels.	W91-11452 2H
W91-11273 7C	W91-11266 7C	SUBSOIL DRAINAGE
Hydrometric Data Collection and Interpretation in the Prairie Provinces and Northwest Territo-	Computation of Uniform Flow in Open Channels with Flood Plains.	Solution in Closed Form and a Series Solution to Replace the Tables for the Thickness of the
ries. W91-11278 7A	W91-11281 2E	Equivalent Layer in Hooghoudt's Drain Spacing Formula.
	Correction Coefficients for Uniform Channel	W91-11430 2G
Estimating Flow Characteristics at Ungauged Sites.	Flow. W91-11282 2E	
W91-11545 2E	Streamflow Generation in a Headwater Basin on	SUBSURFACE DRAINAGE Piping and Pseudokarst in Drylands.
Levels at Streamflow Gaging Stations. W91-11586 7B	the Precambrian Shield.	W91-11561 2F
W91-11586 7B	W91-11349 2E	SUBSURFACE MAPPING
STREAM ORDER	Estimating Flow Characteristics at Ungauged	Delineation of a Discontinuous Aquitard with
Fast Algorithm for Automatically Computing Strahler Stream Order.	Sites. W91-11545 2E	Vertical Electrical Soundings, San Bernardino Valley, Southern California.
W91-10818 2J		W91-10960 5B
STREAM POLLUTION	Drift of the Characin Larvae, Bryconamericus deuterodonoides, During the Dry Season from	SUBSURFACE SYSTEMS
Volatile Organic Compounds in Two Polluted	Andean Piedmont Streams.	Sorotion Phenomena in Subsurface Systems:
Rivers in Barcelona (Catalonia, Spain). W91-10887 5B	W91-11560 2H	Concepts, Models, and Effects on Contaminant Fate and Transport.
Hydrogeochemical Processes Controlling Sub-	Levels at Streamflow Gaging Stations. W91-11586 7B	W91-10882 5B
surface Transport from an Upper Subcatchment	STREAMFLOW FORECASTING	SUBSURFACE WATER
of Walker Branch Watershed During Storm Events. 1. Hydrologic Transport Processes. W91-10907 5B	Risk-based Performance Criteria for Real-time Reservoir Operation.	Hydrogeochemical Processes Controlling Sub- surface Transport from an Upper Subcatchment
	W91-11275 4A	of Walker Branch Watershed During Storm Events. 1. Hydrologic Transport Processes.
Factors Affecting the Relationship Between the NBOD Values and the Amounts of Nitrogenous	Estimating Flow Characteristics at Ungauged	W91-10907 5B
Pollutants: A Field Study on the Lee River. W91-10940 5C	W91-11545 2E	Hydrogeochemical Processes Controlling Sub-
Past, Present, and Future of Water Use and	STREAMS	surface Transport from an Upper Subcatchment of Walker Branch Watershed During Storm
Management.	Diel Oxygen Cycle in Three Subalpine Swiss	Events. 2. Solute Transport Processes.
W91-11209 4A	Streams. W91-10899 2H	W91-10908 5B
Gammarus: Asellus Ratio as an Index of Organic Pollution.	Fate of Acetone in an Outdoor Model Stream	Nitrate Removal by Denitrification in Alluvial Ground Water: Role of a Former Channel.
W91-11331 5A	with a Nitrate Supplement, Southern Mississippi, U.S.A.	W91-10909 5B
Simazine Concentrations in a Stream Draining	W91-10903 5B	Self-Affine Scaling and Subsurface Response to
an Agricultural Catchment. W91-11364 4C	Assessing Stream Values: Perspectives of Aquat-	Snowmelt in Steep Terrain.
	ic Resource Professionals.	W91-10912 2G
STREAM SEDIMENTS  Distance of Movement of Coarse Particles in	W91-11425	SUBTROPIC ZONE
Gravel Bed Streams. W91-11231 2J	Identity of Suspended Particles in a Calcite- Depositing Stream and Their Significance in	Perspectives for Ecological Modelling of Tropi- cal and Subtropical Reservoirs in South Amer-
STREAMBEDS	Trapping and Binding Phenomena. W91-11522 2E	ica. W91-10487 2H
Distance of Movement of Coarse Particles in		
Gravel Bed Streams. W91-11231 2J	Hydrobiological Survey of the Chanomi Creek System, Lower Niger Delta, Nigeria.	SUBURBAN AREAS Non-Point Source Loadings of Nutrients and
STREAMFLOW	W91-11524 5C	Dissolved Organic Carbon from an Agricultural
Comparison of Nocturnal Drainage Flow in	STRESS ANALYSIS	Suburban Watershed in East Central Florida W91-10927 5E
Three Tributaries. W91-10501 2E	Electroosmotic Strengthening of Soft Sensitive Clays.	SULFATES
	W91-10777 8D	Statistical Analysis of Errors in Estimating We
Monthly Mean Discharge at and Between Se- lected Streamflow-Gaging Stations Along the	STRUCTURAL ENGINEERING	Deposition Using Five Surface Estimation Algo
Mississippi, Minnesota, and St. Croix Rivers,	Pressure of Clay Backfill against Retaining	rithms. W91-10474 7E
1932-87. W91-10760 2E	Structures. W91-10947 8D	
	Deep-Seated Consolidation Settlements in the	Determination of Trace Levels of Sulphate in
Statistical Summaries of Selected Iowa Stream- flow Data Through September 30, 1988.	Fraser River Delta.	concentration.
W91-10770 2E	W91-10948 8D	W91-11246 2N

## SULFITE LIQUORS

EULFITE LIQUORS	Superfund Record of Decision: South Valley/	SURFACTANTS
Removal of Acetate from NSSC Sulphite Pulp	Edmunds Street, NM.	Aqueous Surfactant Washing of Residual Oil
Mill Condensates Using Thermophilic Bacteria. W91-10889 5D	W91-10758 5G	Contamination from Sandy Soil. W91-10796 5G
	Superfund Record of Decision: Celanese Fibers	W91-10/96 3G
Future Perspectives for the Anaerobic Treat- ment of Forest Industry Wastewaters.	Operations, NC. W91-10759 5G	Acute Aquatic Toxicity of Alkyl Phenol Ethox-
W91-11478 5D		ylates. W91-10833 5C
Thermophilic Anaerobic Treatment of Sulfate-	Superfund Record of Decision: Intel (Mountain View), CA.	
Rich Pulp and Paper Integrate Process Water.	W91-11581 5G	SURVEYS
W91-11483 5D	Control Designation of the	Preliminary Data Summary for the Pesticide Chemicals Point Source Category.
Biotechnological Sulphide Removal from Ef-	Superfund Record of Decision: Whitmoyer Lab- oratories, PA.	W91-10739 5B
fluents.	W91-11582 5G	
W91-11502 5D	Assessment of Vatarrational Technologies for	Communicating with Farmers: Providing Useful
SULFUR	Assessment of International Technologies for Superfund Applications.	and Reliable Sources of Information. W91-11164 5G
Sulfur Enrichment of Humic Substances in a	W91-11584 5G	w31-11104 3G
Delaware Salt Marsh Sediment Core.	SUPPORTED LIQUID MEMBRANES	Emerging Issues at the Intersection of Agricul-
W91-11258 2L	Fiscal Year 1988 Supported Liquid Membrane	tural and Environmental Policy. W91-11165 5G
1-Naphthalenesulfonic acid and Sulfate as Sulfur	Development Report.	B 411 1 B 111 B 14 14 14 1
Sources for the Green Alga Scenedesmus obli- quus.	W91-10727 5G	Pesticides and Drinking Water Information: A Perspective from EPA's National Pesticide
W91-11326 5D	SURFACE-GROUNDWATER RELATIONS	Survey.
	Comparison of Nocturnal Drainage Flow in	W91-11173 5D
SULFUR DIOXIDE Impact of Changing Regional Emissions on Pre-	Three Tributaries. W91-10501 2E	
cipitation Chemistry in the Eastern United	W91-10301 2E	Stream Chemistry in the Eastern United States:
States.	Hydrological Aspects of the 1988 Drought in	<ol> <li>Synoptic Survey Design, Acid-Base Status, and Regional Patterns.</li> </ol>
W91-10473 5G	Illinois. W91-10810 2B	W91-11241 5B
Mathematical Modelling for Sulphur Dioxide	W91-10810 2B	
Removal from Stack Gases in a Fluidized Bed of	Rhine Rift Valley Groundwater-River Interac-	Stream Chemistry in the Eastern United States:
Activated Sodium Carbonate.	tions: Evolution of their Susceptibility to Pollu- tion.	<ol><li>Current Sources of Acidity in Acidic and Low Acid-Neutralizing Capacity Streams.</li></ol>
W91-11080 5G	W91-10849 5B	W91-11242 5B
SUNFLOWERS		
Trickle Irrigation of Sunflower With Municipal	Computation of Average Seasonal Groundwater Flows in Phreatic Aquifer-River System.	SURVIVAL Protective Effect of Glycine Betaine on Survival
Wastewater. W91-11435 3F	W91-10910 2F	of Escherichia coli Cells in Marine Environ-
SUPERFUND	Self-Affine Scaling and Subsurface Response to	ments.
Superfund Record of Decision: Commencement	Snowmelt in Steep Terrain.	W91-10637 5B
Bay/S. Tacoma, WA.	W91-10912 2G	Effect of Dissolved Nutrients and Inorganic Sus-
W91-10711 5G	Open Channel Velocity Profiles over a Zone of	pended Solids on the Survival of E. coli in
Superfund Record of Decision: Chemtronics	Rapid Infiltration.	Seawater.
(Amendment), NC.	W91-10984 8B	W91-10638 5B
W91-10713 5G	Contribution to the Study of the Recession	Temperatures Lethal to Salvinia molesta Mitch-
Superfund Record of Decision: IBM (San Jose),	Curves of Karstic Springs: Examples from	ell.
CA.	Greece (Contribution a l'Etude des Courses de	W91-11450 2H
W91-10715 5G	Recession des Sources Karstiques: Exemples du Pays Hellenique).	SUSPENDED SEDIMENTS
Superfund Record of Decision: Delaware Sand	W91-10990 2F	Fluidization of Marine Mud by Waves.
and Gravel, DE.		W91-10533 5B
W91-10717 5G	Hydrologic, Meteorological, and Unsaturated- Zone Moisture-Content Data, Franking Lake	Seasonal Influences on the Sediment Transport
Superfund Record of Decision: Pesses Chemical,	Playa, Inyo County, California.	Characteristics of the Sacramento River, Cali-
TX.	W91-11089 2F	fornia.
W91-10718 5G	Evaluation of Three Scenarios of Ground-Water	W91-10847 2J
Superfund Record of Decision: Iron Horse Park,	Withdrawal from the Mississippi River Alluvial	Use of a Single-Bowl Continuous-Flow Centri-
MA.	Aquifer in Northwestern Mississippi.	fuge for Dewatering Suspended Sediments
W91-10719 5G	W91-11106 4B	Effect on Sediment Physical and Chemical
Superfund Record of Decision: South Valley	Evaluation of Analytical Solutions to Estimate	Characteristics.
(PL-83), NM.	Drawdowns and Stream Depletions by Wells.	W91-11350 7E
W91-10721 5G	W91-11240 2F	Relationship of MSS and TM Digital Data with
Superfund Record of Decision: Reich Farms,	Ground-Water Flow and Stream-Aquifer Rela-	Suspended Sediments, Chlorophyll, and Tem-
NJ.	tions in the Northern Coastal Plain of Georgia	perature in Moon Lake, Mississippi.
W91-10743 5G	and Adjacent Parts of Alabama and South Caro-	W91-11354 7C
Superfund Record of Decision. Mid-State Dis-	lina. W91-11598 2F	Effects of Suspended Sediments on Aquatic
posal Landfill, WI.		Ecosystems.
W91-10749 5G	SURFACE RUNOFF	W91-11426 50
Superfund Record of Decision: Kin-Buc Land-	Hydrological Consequences of Artificial Drain- age of Grassland.	Heavy Metal Distribution in the Godvari River
fill, NJ.	W91-11347 2G	Basin.
W91-10755 5G		W91-11445 5E
Superfund Record of Decision: Palmerton Zinc	SURFACE WATER Fate and Transport of Sediment-Associated	Fate and Transport of Sediment-Associated
Pile, PA.	Contaminants.	Contaminants.
W91-10756 5G	W91-11587 5B	W91-11587 51

SUSPENDED SOLIDS	Phenyltins in Water, Sediment, and Biota of	TERATOGENICITY
Heavy Metals Contamination in the Polish Zone	Freshwater Marinas.	Initial Evaluation of Developmental Malforma-
of Southern Baltic. W91-10597 5B	W91-11342 5B	tion as an End Point in Mixture Toxicity Hazard Assessment for Aquatic Vertebrates.
200 . ADI 1 137 . 1	SYMPOSIUM	W91-10832 5C
Effect of Dissolved Nutrients and Inorganic Sus-	Forest Industry Wastewaters.	
pended Solids on the Survival of E. coli in Seawater.	W91-11467 5D	TERRAIN ANALYSIS Fast Algorithm for Automatically Computing
W91-10638 5B	SYNCHAETA	Strahler Stream Order.
Utility Planning Model for the Study of Air	Rotifers of the Genus SynchaetaAn Important Component of the Zooplankton in the Coastal	W91-10818 2J
Pollution Reduction. W91-11079 5G	Waters of the Southern Baltic.	Visual Interpretation of a Landsat Mosaic of the
	W91-11519 2L	Okavango Delta and Surrounding Area. W91-10879 2H
Nature of Suspended Solids and IRS1A-LISSI Data: A Case Study of Tawa Reservoir (Nar-	SYNERGISTIC EFFECTS	W 21-100/9
mada Basin).	Enhancement of Hepatocarcinogenesis in Rain-	TESTING PROCEDURES
W91-11221 5G	bow Trout with Carbon Tetrachloride.	Measurement of the Effect of Organic Pollution
Identity of Suspended Particles in a Calcite-	W91-11301 5C	on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers.
Depositing Stream and Their Significance in	SYNTHETIC FUELS	W91-10469 5A
Trapping and Binding Phenomena.	Status Report on Environment Canada's Oil	TEXAS
W91-11522 2E	From Sludge Technology.	Dallas' Flood Caverns.
SUSTAINABLE DEVELOPMENT	W91-11133 5D	W91-10493 8A
Applying Sustainable Development to the Great	TAMAGAWA RIVER	
Lakes-Experience and Opportunities Under the Boundary Waters Treaty.	Seasonal Changes of Organic Carbon and Nitro-	Superfund Record of Decision: Pesses Chemical, TX.
W91-11019 6E	gen Production by Phytoplankton in the Estuary of River Tamagawa.	W91-10718 5G
SUSTAINED YIELD	W91-10604 5B	Carbodalana and Simulation of Course I Wester
Embedding and Response Matrix Techniques for		Geohydrology and Simulation of Ground-Water Flow in the Mesilla Basin, Dona Ana County,
Maximizing Steady-State Ground-Water Extrac-	Studies on the Bacterial Fauna of the Tamagawa River.	New Mexico, and El Paso County, Texas.
tion; Computational Comparison. W91-10954 2F	W91-10632 5B	W91-11088 2F
	TANABE BAY	Trends in Water-Quality Data in Texas.
SVIR RIVER	Marine Pollution Bioassay by Using Sea Urchin	W91-11593 5E
Selection of the Operating Regime of the Onega- Svir' Water System Under Conditions of In-	Eggs in the Tanabe Bay, Wakayama Prefecture,	THAMES RIVER
creasing Water Consumption.	Japan, 1970-1987.	Thames Water's Experiences with Cryptospori
W91-11288 6D	W91-10602 5A	dium.
SWEDEN	TANNINS	W91-10617 50
Waterborne Disease Outbreak.	Treatment and Detoxification of Aqueous	THE NETHERLANDS
W91-10615 5C	Spruce Bark Extracts by Aspergillus niger. W91-11481 5D	Virological Quality of Recreational Waters in
Trends in Pollution Control In the Swedish Pulp	W91-11461 3D	the Netherlands. W91-10653
and Paper Industry.	TAR BALLS	W91-10633
W91-11469 5G	Tar Balls on Ibeno-Okposo Beach of South-East	Dutch Approach to Manure Processing.
Distribution of Halogenated Organic Com-	Nigeria. W91-10876 5B	W91-10703 5I
pounds (AOX)Swedish Transport to Surround- ing Sea Areas and Mass Balance Studies In Five		Processing Organic Waste Products to Black
Drainage Systems.	TAWA RESERVOIR	Soil and Organic Fertilizers.
W91-11506 5B	Nature of Suspended Solids and IRS1A-LISSI Data: A Case Study of Tawa Reservoir (Nar-	W91-10705 51
SWIMMING	mada Basin).	Analysis of Halogenated Acetic Acids in Dutch
EC Bathing Water Virological Standard: Is It	W91-11221 5G	Drinking Water.
Realistic.	TELEBER ATTIBE	W91-10938 51
W91-10622 5A	TEMPERATURE Comparative Study and Mathematical Modeling	Odour Problems with Sewage Sludge.
Disinfection Capability in Water for Swimming	of Temperature, Light and Growth of Three	W91-11121 51
and Bathing Pools: A Simple Method for Their	Microalgae Potentially Useful for Wastewater	Sludge Treatment in Amsterdam: Economica
Evaluation in Practice.	Treatment.	Technical and Environmental Experiences.
W91-10684 5F	W91-10937 5D	W91-11132 5I
Results of the First Pilot-Scale Controlled	Relationship of MSS and TM Digital Data with	Paris and Asset of Yandfilles Clade
Cohort Epidemiological Investigation into the	Suspended Sediments, Chlorophyll, and Tem-	Environmental Aspects of Landfilling Sludge W91-11136 51
Possible Health Effects of Bathing in Seawater	perature in Moon Lake, Mississippi.	
at Langland Bay, Swansea. W91-11366 5C	W91-11354 7C	Sludge Treatment and Tipping Site 'Harte
	TEMPERATURE EFFECTS	mond'. W91-11140
SWITZERLAND	Effect of Heat Shock on Recovery of Escheri-	W91-11140 51
Diel Oxygen Cycle in Three Subalpine Swiss Streams.	chia coli from Drinking Water.	Wet Oxydation as the Alternative for Sewag
W91-10899 2H	W91-10628 5F	Sludge Treatment.
	Interrelations Between Amoebae and Bacteria in	W91-11146 51
Pathway Analysis of Selected Organic Chemi- cals from Sewage to Agricultural Soil.	the Moselle River, France.	Sludge Dewatering: First Membrane Filterpres
W91-11123 5B	W91-10650 5B	Plant in the Netherlands Operational.
	Temperatures Lethal to Salvinia molesta Mitch-	W91-11155 51
Thermophilic Aerobic Stabilisation. W91-11134 5D	ell.	Sludge Studies on Sludge Management: Strate
	W91-11450 2H	gic Studies on Sludge.
Ban on Phosphorus in Detergents: The Effects	TEMPERATURE GRADIENT	W91-11156 51
on the Phosphorus Contents of Swiss Sewage Sludges and on the Efficiency of Phosphorus	Numerical Simulations of the Evolution of a	Air Quality and Deposition of Trace Elements
Elimination by Sewage Treatment Plants.	Cold Front and its Precipitation.	the Province of South-Holland.
W91-11142 5D		W91-11248 5

#### THE NETHERLANDS

Use of 137Cs as a Tracer in an Erosion Study in	Microwave Transmission, a New Tool in Forest	Field Survey and Hydraulic Study of 'Aoshio' in
South Limburg (The Netherlands) and the Influ-	Hydrological Research.	Tokyo Bay.
ence of Chernobyl Fallout.	W91-10995 2I	W91-10529 5C
W91-11351 7B	THUNDERSTORMS	TOLUENE
Investigations With Electrodialysis Reversal for	Electrical and Kinematic Structure of the Strati-	Health Risk Assessment of Toluene in California
the Treatment of Surface Water to Make-Up Water.	form Precipitation Region Trailing an Oklahoma Squall Line.	Drinking Water. W91-10741 5C
W91-11368 5F	W91-10514 2B	W91-10/41 SC
THE TOTAL POLICE	Political Political CTI and a state of the last	Stimulation of the Reductive Dechlorination of
THEIS EQUATION  Discrete-Kernel Method for Simulating Pump-	Persistent Patterns of Thunderstorm Activity in the Central United States.	Tetrachloroethene in Anaerobic Aquifer Micro-
ing Tests in Large-Diameter Wells.	W91-11411 2B	cosms by the Addition of Toluene. W91-11344 5B
W91-10998 2F		W 91-11344
WINDLE LINGS DAY	Kinematic, Dynamic, and Thermodynamic	TOURISM
THERMAIKOS BAY Water Quality Assessment and Protection Meas-	Analysis of a Weakly Sheared Severe Thunder- storm over Northern Alabama.	Water Quality Management Issues in Lingayen
ures of a Semi-Enclosed Coastal Area: The Bay	W91-11417 2B	Gulf, Philippines and Some Proposed Solutions. W91-10523 5G
of Thermaikos (NE Mediterranean Sea). W91-10534 5G	Squall Line in Southern Germany: Kinematics	Ecological Assessment of Semi-Enclosed Marine
	and Precipitation Formation as Deduced by Ad-	Water Bodies of the Archipelago Sabana-Cama-
THERMAL ENERGY	vanced Polarimetric and Doppler Radar Meas-	guey (Cuba) Prior to Tourism Development
Relationship of Regional Water Quality to Aqui- fer Thermal Energy Storage.	urements. W91-11420 2B	Projects.
W91-11082 5C	1171-11720	W91-10566 6G
	Assessment of VAS-Derived Retrievals and Pa-	TOXIC WASTES
THERMAL POLLUTION	rameters used in Thunderstorm Forecasting.	Managing Toxic Substances in Municipal
Effects of Pollution on Heterozygosity in the Barnacle Balanus amphitrite (Cirripedia: Thora-	W91-11423 2B	Wastewater Treatment Plants.
cica).	TILE DRAINS	W91-11540 5D
W91-10518 5C	Assessment of Agricultural Nutrient Point	TOXICITY
	Source Discharge from Tile Drains, Spring and	Meiofauna of an Experimental Soft Bottom Eco-
Comprehensive Cooling Water Study, Final	Overland Runoff from Two Farms, Dauphin County, Pennsylvania.	systemEffects of Macrofauna and Cadmium
Report. Volume I: Summary of Environmental Effects.	W91-11600 5B	Exposure.
W91-10729 5B		W91-10519 5C
	TIMBERLINE	Microbiological Methods for Safety Testing of
THERMAL-PULSE FLOWMETERS Thermal-Pulse Flowmeter for Measuring Slow	Microclimatological Investigations in the Tropi- cal Alpine Scrub of Maui, Hawaii: Evidence for	Drinking Water Directly Reclaimed from
Water Velocities in Boreholes.	a Drought-Induced Alpine Timberline.	Wastewater.
W91-10766 8G	W91-10878 2I	W91-10613 5A
THERMAL SPRINGS	TIME SERIES ANALYSIS	Biochemical and Histochemical Observations on
Characterization of Radioactivity in Hot Springs	Simulation of Precipitation by Weather Type	Effects of Low-Level Metal Load (Lead, Cad-
National Park, Arkansas.	Analysis.	mium) in Different Organ Systems of the Fresh-
W91-10846 2K	W91-11230 2B	water Crayfish, Astacus astacus L. (Crustacea: Decapoda).
THERMAL STRATIFICATION	TIN	W91-10827 5B
Formation of Oxygen-Deficient Water Mass in	Methyl and Butyltin Compounds in Water and	
Omura Bay.	Sediments of the Rhine River.	Effect of 3,4-Dichloroaniline on the Early Life Stages of the Zebrafish (Brachydanio rerio): Re-
W91-10592 5B	W91-11335 5B	sults of a Comparative Laboratory Study.
Shifts in Fish Vertical Distribution in Response	Phenyltins in Water, Sediment, and Biota of	W91-10828 5A
to an Internal Seiche in a Stratified Lake.	Freshwater Marinas.	
W91-10864 2H	W91-11342 5B	Ultrastructural and Biochemical Effects of Cad- mium on the Aquatic Fern Marsilea minuta
THERMODYNAMICS	TISSUE ANALYSIS	Linn.
Energy Transformation-Ecology Interface from	Assessment of Methods for the Microbiological	W91-10829 5C
a Nonlinear, Nonequilibrium Thermodynamic	Analysis of Shellfish.	
Perspective.	W91-10695 5A	Ecotoxicological Effects Assessment: A Com- parison of Several Extrapolation Procedures.
W91-11085 5B	Subchronic Hepatotoxicity of Selenomethionine	W91-10830 5A
Kinematic, Dynamic, and Thermodynamic	Ingestion in Mallard Ducks.	
Analysis of a Weakly Sheared Severe Thunder-	W91-10838 5C	Initial Evaluation of Developmental Malforma-
storm over Northern Alabama.	226-Ra and Other Radionuclides in Water,	tion as an End Point in Mixture Toxicity Hazard Assessment for Aquatic Vertebrates.
W91-11417 2B	Vegetation, and Tissues of Beavers (Castor cana-	W91-10832 5C
THERMOPHILIC BACTERIA	densis) from a Watershed Containing U Tailings	
Aerobic Thermophilic Digestion of Pre-Thick-	Near Elliot Lake, Canada.	Acute Aquatic Toxicity of Alkyl Phenol Ethox-
ened Sludge Using Air. W91-10704 5D	W91-11454 5B	ylates. W91-10833 5C
W91-10/04 3D	TITANIUM DIOXIDE	W71-10033
Removal of Acetate from NSSC Sulphite Pulp	Impact of Titanium Dioxide Waste on Fertiliza-	Effect of Pesticide Treatments on Nontarget Or-
Mill Condensates Using Thermophilic Bacteria.	tion in the Sea Urchin Echinometra mathaei.	ganisms in California Rice Paddies.
W91-10889 5D	W91-10870 5C	W91-10835 5C
Thermophilic Aerobic Stabilisation.	TOGA RIVER	Dioxin Contamination and Growth and Devel-
W91-11i34 5D	Citizen's Movements to Protect the Environ-	opment in Great Blue Heron Embryos.
THROUGHFALL	ment of Rivers Flowing into the Seto Inland Sea: An Example of a Citizen's Movement	W91-10837 5C
Dry Deposition Washoff from Forest Tree	Along the Toga River.	Subchronic Hepatotoxicity of Selenomethionine
Leaves by Experimental Acid Rainfall.	W91-10587 5G	Ingestion in Mallard Ducks.
W91-10476 5B		W91-10838 5C
Rainfall Interception and Boundary Layer Con-	TOKYO BAY Numerical Simulation of Water Quality in	Trace Metal Interactions with Marine Phyto-
ductance in Relation to Tree Spacing.	Tokyo Bay.	plankton.
W91-10905 2I	W91-10528 5B	W91-10853 2L

Effects of pH and Aluminum on the Growth of the Acidophilic Diatom Asterionella ralfsii var.	Ultrastructural and Biochemical Effects of Cad- mium on the Aquatic Fern Marsilea minuta	TRACE LEVELS  Determination of Trace Levels of Sulphate in
americana. W91-10862 2H	Linn. W91-10829 5C	Water Using Flow-Injection and In-Line Pre- concentration.
	Ecotoxicological Effects Assessment: A Com-	W91-11246 2K
Impact of Titanium Dioxide Waste on Fertiliza- tion in the Sea Urchin Echinometra mathaei.	parison of Several Extrapolation Procedures.	Multimethod for Pesticides in Soil at Trace
W91-10870 5C	W91-10830 5A	Level. W91-11309 5A
Immunochemical Detection of Cytochrome P450IA1 Induction in Cod Larvae and Juveniles	Acute Aquatic Toxicity of Alkyl Phenol Ethox- ylates.	
Exposed to a Water Soluble Fraction of North	W91-10833 5C	TRACE METALS  Effect of a Spring Phytoplankton Bloom on
Sea Crude Oil. W91-10871 5A	Dioxin Contamination and Growth and Devel-	Dissolved Copper Speciation in Bedford Basin.
	opment in Great Blue Heron Embryos. W91-10837 5C	W91-10543 5B
Effects of Linear Alkylbenzene Sulphonate (LAS) on Skeletal Development of Sea Urchin	Subchronic Hepatotoxicity of Selenomethionine	Trace Metal Interactions with Marine Phyto-
Embryos (Paracentrotus lividus LMK). W91-10891 5C	Ingestion in Mallard Ducks. W91-10838 5C	plankton. W91-10853 2L
		Estimation of Trace Metals Levels in Power and
Effects of Copper and Tributyltin on Stress Pro- tein Abundance in the Rotifer Brachionus plica-	Immunochemical Detection of Cytochrome P450IA1 Induction in Cod Larvae and Juveniles	Industrial Waste Water of Jodhpur by Differen- tial Pulse Anodic Stripping Voltammetry.
tilis. W91-10900 5C	Exposed to a Water Soluble Fraction of North Sea Crude Oil.	W91-11084 SA
	W91-10871 5A	Sequential Sampling of Particles, Major Ions and
Decreased Norepinephrine and Epinephrine Contents in Chromaffin Tissue of Rainbow	Effects of Linear Alkylbenzene Sulphonate	Total Trace Metals in Wet Deposition.
Trout (Oncorhynchus mykiss) Exposed to	(LAS) on Skeletal Development of Sea Urchin Embryos (Paracentrotus lividus LMK).	W91-11249 5B
Diethyldithiocarbamate and Amylxanthate. W91-10901 5C	W91-10891 5C	Modelling the Atmospheric Transport of Trace
Acute Phototoxicity of Harbor and Tributary	Effects of Copper and Tributyltin on Stress Pro-	Metals Including the Role of Precipitating Clouds.
Sediments from Lower Lake Michigan.	tein Abundance in the Rotifer Brachionus plica- tilis.	W91-11251 5B
W91-10977 5C	W91-10900 5C	Low Cost Flow Injection Analysis for Cadmium
Standard Test Fish for India and the Neighbor-	Decreased Norepinephrine and Epinephrine	Using 2-(2-benzothiazolylazo) -4,5-Dimethyl-
ing Countries. W91-11300 5A	Contents in Chromaffin Tissue of Rainbow Trout (Oncorhynchus mykiss) Exposed to	phenol. W91-11379 5A
	Diethyldithiocarbamate and Amylxanthate.	TRACERS
Enhancement of Hepatocarcinogenesis in Rain- bow Trout with Carbon Tetrachloride.	W91-10901 5C	Application of Microbial Tracers in Groundwat-
W91-11301 5C	Sensitive High-Performance Liquid Chromato-	er Studies.
Toxicity of Metals to a Freshwater Tubificid	graphic Analysis for Toxicological Studies with Carbaryl.	W91-10671 5E
Worm, Tubifex tubifex (Muller). W91-11303 5C	W91-10920 5A	Behaviour of Pathogenic Bacteria, Phages and Viruses in Groundwater During Transport and
	LC-50 Estimates and Their Confidence Intervals	Adsorption.
Assessment of Mercury Toxicity by the Changes in Oxygen Consumption and Ion Levels in the	Derived for Tests with Only One Concentration with Partial Effect.	W91-10672 5E
Freshwater Snail, Pila globosa, and the Mussel,	W91-10930 5C	Field Experiments with Microbiological Tracers
Lamellidens marginalis. W91-11304 5C	Acute Phototoxicity of Harbor and Tributary	in a Pore Aquifer. W91-10673 5E
Fertility of Workers Chronically Exposed to	Sediments from Lower Lake Michigan. W91-10977 5C	Characteristics of Rhodamine WT and Fluores
Chemically Contaminated Sewer Wastes.	Standard Test Fish for India and the Neighbor-	cein as Adsorbing Ground-Water Tracers.
W91-11316 5D	ing Countries.	W91-10952 5E
Anaerobic Toxicity of Fines In Chemi-thermo-	W91-11300 5A	Automatic Tracer-Dilution Method Used for
mechanical Pulp Wastewaters: A Batch Assay- Reactor Study Comparison.	Enhancement of Hepatocarcinogenesis in Rain- bow Trout with Carbon Tetrachloride.	Stage-Discharge Ratings and Streamflow Hy- drographs on Small Iowa Streams.
W91-11479 5D	W91-11301 5C	W91-11111 7E
Anaerobic Biodegradability and Methanogenic	Toxicity of Metals to a Freshwater Tubificid	Geostatistical Characteristics of the Borden Aq
Toxicity of Pulping Wastewaters.	Worm, Tubifex tubifex (Muller). W91-11303 5C	uifer.
W91-11480 5D		W91-11234 2F
TOXICOLOGY	Assessment of Mercury Toxicity by the Changes in Oxygen Consumption and Ion Levels in the	New Approach to Tracer Transport Analysis
Induction of Biotransformation in the Liver of Eel (Anguilla anguilla L.) by Sublethal Exposure	Freshwater Snail, Pila globosa, and the Mussel,	From Fracture Systems to Strongly Heterogene ous Porous Media.
to Dinitro-o-cresol: An Ultrastructural and Bio- chemical Study.	Lamellidens marginalis. W91-11304 5C	W91-11554 2F
W91-10826 5C	TRACE ELEMENTS	TRAINING
Biochemical and Histochemical Observations on	Air Quality and Deposition of Trace Elements in	Professionalism in Agriculture: Seeking a Train
Effects of Low-Level Metal Load (Lead, Cad-	the Province of South-Holland. W91-11248 5B	ing Standard. W91-11198 50
mium) in Different Organ Systems of the Fresh- water Crayfish, Astacus astacus L. (Crustacea:		
Decapoda).	Sequential Sampling of Particles, Major Ions and Total Trace Metals in Wet Deposition.	Developing a Groundwater Training Program for Pesticide Users.
W91-10827 5B	W91-11249 5B	W91-11199 50
Effect of 3,4-Dichloroaniline on the Early Life	Trace Element Distribution in Surficial Sedi-	Florida's Pesticide Water Quality Education
Stages of the Zebrafish (Brachydanio rerio): Re- sults of a Comparative Laboratory Study.	ments of the Northern Tyrrhenian Sea: Contri- bution to Heavy-Metal Pollution Assessment.	Program.
W91-10828 5A	W91-11444 5A	W91-11202 50

## TRANSPARENCY

TRANSPARENCY	Convective Cell in a Hurricane Rainband.	Sasahi Diek and Dhatamater Estimates of Light
Secchi Disk and Photometer Estimates of Light Regimes in Alaskan Lakes: Effects of Yellow	W91-11422 2B	Secchi Disk and Photometer Estimates of Light Regimes in Alaskan Lakes: Effects of Yellow Color and Turbidity.
Color and Turbidity.	TROPICAL REGIONS	W91-10860 2H
W91-10860 2H	Perspectives for Ecological Modelling of Tropi-	
Ontire of Little Sedus Born	cal and Subtropical Reservoirs in South Amer- ica.	TURBINES
Optics of Little Sodus Bay. W91-10980 2H	W91-10487 2H	Development of Small Hydro for Remote Areas of Northern Pakistan.
TRAPPING	Mathematical Modelling for Reservoir Water-	W91-11215 8C
Identity of Suspended Particles in a Calcite-	Quality Management Through Hydraulic Struc-	Hydroelectric Turbine Setting: A Rational Ap-
Depositing Stream and Their Significance in	tures: A Case Study.	proach.
Trapping and Binding Phenomena.	W91-10490 5G	W91-11274 8C
W91-11522 2E	Microclimatological Investigations in the Tropi-	Operating Experience and Suggestions on Re-
TREATIES	cal Alpine Scrub of Maui, Hawaii: Evidence for	construction of the Turbines of the Dnepr-I Hy-
Resale of the Columbia River Treaty Down- stream Power Benefits: One Road from Here to	a Drought-Induced Alpine Timberline. W91-10878 2I	droelectric Station. W91-11290 8C
There. W91-11386 6E	Assessment of Water Pollution using Diatom	TURKEY
W 91-11300	Community Structure and Species Distribution-	Man-Made Garbage Pollution on the Mediterra-
Agency Autonomy in Transboundary Resource	A Case Study in a Tropical River Basin.	nean Coastline.
Management: The United States Section of the	W91-11404 5C	W91-10569 5B
International Boundary and Water Commission, United States and Mexico.	Drift of the Characin Larvae, Bryconamericus	TUDNOVED TIME
W91-11388 6E	deuterodonoides, During the Dry Season from	TURNOVER TIME Role of Seasonal Turnover in Lake Alkalinity
	Andean Piedmont Streams. W91-11560 2H	Dynamics.
TREES	W91-11360 2H	W91-10861 2H
Rainfall Interception and Boundary Layer Con-	TROUT	
ductance in Relation to Tree Spacing. W91-10905 2I	Decreased Norepinephrine and Epinephrine	TYRRHENIAN SEA Trace Element Distribution in Surficial Sedi-
	Contents in Chromaffin Tissue of Rainbow	ments of the Northern Tyrrhenian Sea: Contri-
Tree-Ring Reconstructed Sunshine Duration	Trout (Oncorhynchus mykiss) Exposed to Diethyldithiocarbamate and Amylxanthate.	bution to Heavy-Metal Pollution Assessment.
over Central USA.	W91-10901 5C	W91-11444 5A
W91-10972 2I		THE LAND
TRIAZINE PESTICIDES	Enhancement of Hepatocarcinogenesis in Rain- bow Trout with Carbon Tetrachloride.	UKRAINE Physical Properties of Irrigated Chernozems of
Solid-Phase Extraction for Multi-Residue Analy-	W91-11301 5C	the Southern Ukraine.
sis of Some Triazole and Pyrimidine Pesticides	W71-11301	W91-10915 2G
in Water. W91-11313 5A	Sensitivity of Greenback Cutthroat Trout to	
W7F11313	Acidic pH and Elevated Aluminum. W91-11531 5C	ULTRAFILTRATION
TRIBUTARIES	W91-11331	Rotavirus Detection: A Problem that Needs Concentration.
Comparison of Nocturnal Drainage Flow in	TRUCKEE RIVER	W91-10656 5A
Three Tributaries. W91-10501 2E	Phosphorus in the Truckee River Between Vista	
	and Patrick, Storey and Washoe Counties, Nevada, August 1984.	Use of Ligand-Modified Micellar-Enhanced Ul-
TRICHLOROETHYLENE	W91-10763 5A	trafiltration in the Selective Removal of Metal Ions from Water.
Soil Vapor Survey at the LLNL Site 300 Gener- al Services Area, Adjacent Portions of the Con-		W91-11318 5D
nolly and Gallo Ranches and the Site 300 Land-	TUBIFICIDS Toxicity of Metals to a Freshwater Tubificid	
fill Pit 6 Area.	Worm, Tubifex tubifex (Muller).	ULTRAVIOLET RADIATION UV Disinfection: Short Term Inactivation and
W91-10747 5B	W91-11303 5C	Revival.
TRICKLE IRRIGATION	TUNA	W91-10680 5F
Trickle Irrigation of Sunflower With Municipal	Mercury Body Burden and Otolith Characteris-	
Wastewater.	tics of Bluefin Tuna from the Northwest Medi-	UV Disinfection of Secondary Effluents from
W91-11435 3F	terranean (Balearic Sea).	Sewage Treatment Plants. W91-10681 5D
TRITIUM	W91-10881 2L	***************************************
Tritium as an Indicator of Ground-Water Age in	TUNNEL CONSTRUCTION	F-Specific RNA Bacteriophages as Model Vi-
Central Wisconsin.	Analysis of Three-Dimensional Ground Move-	ruses in UV Disinfection of Wastewater. W91-10682 5D
W91-10958 2F	ments: The Thunder Bay Tunnel.	W 21-10002
Depth of Fractures and Active Ground-Water	W91-10775 8A	Algicidal and Chemical Effect of u.vRadiation
Flow in a Clayey Till Plain in Southwestern	TUNNELING	of Water Containing Humic Substances.
Ontario.	Analysis of Three-Dimensional Ground Move-	W91-10941 5F
W91-10959 2F	ments: The Thunder Bay Tunnel.	UNCERTAINTY
TROPHIC LEVEL	W91-10775 8A	Uncertainty in the Projection of Carbon Dioxide
Primary Productivity and Plankton Communi-	TUNNELS	Emissions.
ties in a Two-Reservoir Series.	Investigation of Local Scour in Cohesionless	W91-11069 5B
W91-10815 2H	Sediments Using a Tunnel-Model.	UNCONSOLIDATED AQUIFERS
Zooplankton Effects on Phytoplankton in Lakes	W91-10746 2J	Availability of Ground Water from Unconsoli-
of Contrasting Trophic Status.	Abbeystead Outfall Works: Background to Re-	dated Deposits in the Mohawk River Basin,
W91-10859 2H	pairs and Modifications and Lessons Learned.	New York.
TROPICAL AREAS	W91-11355 5D	W91-11104 2F
Effects of Land Use Alteration on Tropical	Channel Tunnel and Its Impact on the Folkes-	UNIFORM FLOW
Carbon Exchange.	tone and District Water Company.	Computation of Uniform Flow in Open Chan-
W91-11072 4C	W91-11363 4C	nels with Flood Plains.
TROPICAL CYCLONES	TURBIDITY	W91-11281 2E
Sensitivity Studies of Tropical Storm Genesis	Investigation on Turbidity and Flow Patterns in	Correction Coefficients for Uniform Channel
Using a Numerical Model.	Half-Closed Sea Area.	Flow.
W91-11421 2B	W91-10532 5B	W91-11282 2E

I TAUTE LINE DOCUMENTO	1 110	
UNIT HYDROGRAPHS	densis) from a Watershed Containing U Tailings	Heavy Metal Distribution in the Godvari River
Unit Hydrographs for Developing Design Flood Hydrographs.	Near Elliot Lake, Canada.	Basin.
W91-10809 2E	W91-11454 5B	W91-11445 5B
W 31-10803	URBAN AREAS	UREAS
UNITED ARAB EMIRATES	Bacterial Water Quality in Urban Receiving	Model of Ammonia Volatilization From Applied
Application of Uphole Data from Petroleum	Waters.	Urea. V. The Effects of Steady-State Drainage
Seismic Surveys to Groundwater Investigations,	W91-10633 5B	and Evaporation.
Abu Dhabi (United Arab Emirates).		W91-10805 3F
W91-11399 7C	Incidence of Legionella in the Urban Environ-	
UNITED KINGDOM	ment in Australia.	Model of Ammonia Volatilization From Applied
Preliminary Statistical Assessment of UK Water	W91-10929 5B	Urea. VI. The Effects of Transient-State Water
Quality Control Trials.	III- Desirid- West- Manager Control	Evaporation.
W91-10624 5G	Urban Pesticide Waste Management: Strategies for Education and Collection.	W91-10806 3F
	W91-11194 5E	US GEOLOGICAL SURVEY
Occurrence and Viability of Giardia spp. Cysts	W 21-11124 3E	Overview of U.S. Geological Survey Water-
in UK Waters.	URBAN CLIMATOLOGY	Resources Information Programs.
W91-10647 5B	Precipitation Changes in Fall, Winter, and	W91-11166 IOD
UNITED STATES	Spring Caused by St Louis.	
Agency Autonomy in Transboundary Resource	W91-10500 2B	USSR
Management: The United States Section of the		Soil Moisture: Empirical Data and Model Re-
International Boundary and Water Commission,	URBAN DEVELOPMENT	sults.
United States and Mexico.	Urbanization and Urban Water Problems in	W91-11413 2G
W91-11388 6E	Southeast Asia: A Case of Unsustainable Devel-	*****
UNIVERSAL SOIL LOSS EQUATION	opment.	UTAH
Advances in Wind and Water Erosion Predic-	W91-11263 6G	Hydrologic Characteristics of the Great Salt Lake, Utah: 1847-1986.
tion.	URBAN HYDROLOGY	W91-11597 2H
W91-10509 2J	Precipitation Changes in Fall, Winter, and	2H
	Spring Caused by St Louis.	UTILITIES
RUSLE: Revised Universal Soil Loss Equation.	W91-10500 2B	Utility Planning Model for the Study of Air
W91-10510 2J		Pollution Reduction.
UNSATURATED FLOW	Techniques for Estimation of Storm-Runoff	W91-11079 5G
Comparison of Measured and Estimated Unsatu-	Loads, Volumes, and Selected Constituent Con-	
rated Hydraulic Conductivities During Snow-	centrations in Urban Watersheds in the United	VAPOR DIFFUSION
melt.	States. W91-11094 5B	Vapor Diffusional Growth of Free-Falling
W91-10904 2G	W91-11094 5B	Snow Crystals Between -3 and -23 C. W91-10515 2C
	Urbanization and Urban Water Problems in	W91-10313 2C
Improved Analysis of Gravity Drainage Experi-	Southeast Asia: A Case of Unsustainable Devel-	VATTERN (LAKE)
ments for Estimating Unsaturated Soil Hydraulic	opment.	Organohalogens of Natural and Industrial Origin
Functions. W91-11237 2G	W91-11263 6G	In Large Recipients of Bleach-Plant Effluents.
W91-11237 2G		W91-11505 5B
UNSATURATED ZONE	URBAN RUNOFF	
Hydrologic, Meteorological, and Unsaturated-	Urban Storm-Induced Discharge Impacts.	VEGETATION EFFECTS
Zone Moisture-Content Data, Franking Lake	W91-10745 5B	Influence of Green Plants on the World Carbon
Playa, Inyo County, California.	Effects of Land-Use Buffer Size on Spearman's	Budget. W91-11071 2K
W91-11089 2F	Partial Correlations of Land Use and Shallow	W91-110/1
UNSTEADY FLOW	Ground-Water Quality.	VEGETATION ESTABLISHMENT
Modelling Water and Solute Transport in Ma-	W91-10761 4C	Revegetation Technologies.
croporous Soil. II. Chloride Breakthrough		W91-11568 4D
Under Non-Steady Flow.	Hydrocarbons in Urban Runoff: Their Contribu- tion to the Wastewaters.	ATEMPE BEITER BACKS
W91-10804 2G	W91-10885 5B	VERDE RIVER BASIN
UPWELLING	W91-10885 3B	Photographs Written Historical and Descriptive
Field Survey and Hydraulic Study of 'Aoshio' in	Non-Point Source Loadings of Nutrients and	Data. W91-11577 6E
Tokyo Bay.	Dissolved Organic Carbon from an Agricultural-	W91-115//
W91-10529 5C	Suburban Watershed in East Central Florida.	VERTICAL DISTRIBUTION
	W91-10927 5B	Shifts in Fish Vertical Distribution in Response
Change of Oceanic Condition by the Man-Made		to an Internal Seiche in a Stratified Lake.
Structure for Upwelling.	Dynamic Simulation of Storm Tanks.	W91-10864 2H
W91-10542 8I	W91-10928 5D	MBD ATTONS
URANIUM	Techniques for Estimation of Storm-Runoff	VIBRATIONS
Fiscal Year 1988 Supported Liquid Membrane	Loads, Volumes, and Selected Constituent Con-	In-Flow Vibrations of Gate Edges. W91-10724 8B
Development Report.	centrations in Urban Watersheds in the United	W91-10724 8B
W91-10727 5G	States.	VIBRIO
6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	W91-11094 5B	Occurrence of V. cholerae 0:1 Non-Toxigenic in
Geochemical Evolution in the Cambrian-Ordo- vician Sandstone Aguifer, Eastern Wisconsin: 1.		Wastewaters from Sao Paulo, Brazil.
Major Ion and Radionuclide Distribution.	New Storm Water Regulations Require Signifi-	W91-10685 5D
W91-10953 2K	cant Compliance Actions by Both Industries and	Description of New OI William Statements Tourist
	Municipalities.	Dynamics of Non-01 Vibrio cholerae in Experi-
Study on Triple-Membrane-Separator (TMS)	W91-11541 5D	mental Sewage Stabilization Ponds Under Arid
Process to Treat Aqueous Effluents Containing	URBAN WATERSHEDS	Mediterranean Climate. W91-10690 5D
Uranium.	Bacterial Water Quality in Urban Receiving	W 71-10090 5D
W91-11367 5D	Waters.	VIRUSES
Application of Supported Liquid Membranes for	W91-10633 5B	Use of Risk Assessment for Development of
Removal of Uranium From Groundwater.		Microbial Standards.
W91-11370 5G	URBANIZATION	W91-10619 5G
	Interstate Cooperation in Dealing with Growth	EC Bathing Water Virological Standard: Is It
URANIUM MINING	Related Water Quality Impacts on the Chesa-	Realistic.
226-Ra and Other Radionuclides in Water,	peake Bay. W91-11009 6E	W91-10622 5A

#### VIRUSES

Review of the Epidemiology and Diagnosis of Waterborne Viral Infections.	Transport of Microorganisms in the Under- ground: Processes, Experiments and Simulation	Soil Clean Up by In-situ Aeration: VI. Effects of Variable Permeabilities.
W91-10651 5B	Models.	W91-11317 5G
Virological Investigation of the River Elbe.	W91-10674 5B	Direct Sampling Ion Trap Mass Spectrometry for the Rapid Determination of Volatile Organ-
W91-10652 5B	Comparative Inactivation of Hepatitis A Virus and Other Enteroviruses in Water by Iodine.	ics in Environmental Matrices.
Virological Quality of Recreational Waters in the Netherlands.	W91-10679 5F	W91-11555 5A
W91-10653 5B	F-Specific RNA Bacteriophages as Model Vi-	Superfund Record of Decision: Intel (Mountain
Elimination of Coliphages, Clostridium perfrin-	ruses in UV Disinfection of Wastewater. W91-10682 5D	View), CA. W91-11581 5G
gens and Human Enteric Viruses During Drink- ing Water Treatment: Results of Large Volume	Activity of Peracetic Acid on Sewage Indicator	VOLATILIZATION
Samplings.	Bacteria and Viruses.	Model of Ammonia Volatilization From Applied
W91-10654 5F	W91-10683 5D	Urea. V. The Effects of Steady-State Drainage and Evaporation.
Improvement of the Zeta-Plus Filter Method for	Comparative Study on Adsorption Mechanisms	W91-10805 3F
Concentration of Viruses from Water.	of RNA-F-Specific Coliphages and Poliovirus in Activated Sludge Process.	Model of Ammonia Volatilization From Applied
W91-10655 5A	W91-10694 5D	Urea. VI. The Effects of Transient-State Water
Rotavirus Detection: A Problem that Needs	Assessment of Methods for the Microbiological	Evaporation. W91-10806 3F
Concentration. W91-10656 5A	Analysis of Shellfish.	W91-10800
W71-10030	W91-10695 5A	VOLCANOES
Recovery of Enterovirus from Primary Sludge	Detoxification by Sephadex LH20 of Seafood	Snow and Ice Perturbation during Historical Volcanic Eruptions and the Formation of
Using Three Elution Concentration Procedures. W91-10657 5A	Concentrates for Rotavirus Assay.	Lahars and Floods.
	W91-10696 5A	W91-11394 2C
Concentration of Hepatitis A Virus in Environ-	Comparison of Two Methods for the Recovery	VOLTAMMETRY
mental Samples. W91-10658 5A	of Rotavirus from Mussels and Oysters.	Voltammetric Determination of the Complexa-
	W91-10697 5A	tion Parameters of Zinc in Marine and Estuarine
Adsorption of Viruses by Diatomaceous Earth Coated with Metallic Oxides and Metallic Per-	Comparison of Methods for the Isolation of a	Waters. W91-10924 2K
oxides.	Wide Range of Viruses from Shellfish.	
W91-10659 5A	W91-10698 5A	Estimation of Trace Metals Levels in Power and Industrial Waste Water of Jodhpur by Differen-
Detection of Rotavirus in South African Waters:	Bacteriophages as Model Viruses in Water Qual-	tial Pulse Anodic Stripping Voltammetry.
A Comparison of a Cytoimmunolabelling Tech-	ity Control. W91-10883 5G	W91-11084 5A
nique with Commercially Available Immunoas-		WALES
says. W91-10660 5A	Package Water Plant Filters to 0.02 N.T.U. W91-11225 5F	Precipitation in Britain: An Analysis of Area- Average Data Updated to 1989.
Difficulty of Using Coliphages as 'Indicators'	Laboratory Studies of Virus Survival During	W91-10973 2B
and 'Index' Organisms.	Aerobic and Anaerobic Digestion of Sewage	Rainfall Interception by Trees of Pinus radiata
W91-10661 5A	Sludge.	and Eucalyptus viminalis in a 1300 mm Rainfall
Occurrence of Male-Specific and Somatic Bac-	W91-11319 5D	Area of Southeastern New South Wales: I. Gross Losses and Their Variability.
teriophages in Polluted South African Waters. W91-10662 5B	VOLATILE ORGANIC COMPOUNDS	W91-11345 2D
W91-10662 5B	Preliminary Data Summary for the Pharmaceuti- cal Manufacturing Point Source Category.	WACH WATER
Polyvalent Coliphages in Sewage.	W91-10710 5B	WASH WATER Pesticide Rinseate Management Plan.
W91-10663 5A	Tourshill of House Charles in Sails	W91-11195 5G
Detection of Hepatitis A Virus and Other Enter-	Treatability of Hazardous Chemicals in Soils: Volatile and Semivolatile Organics.	WASHINGTON
oviruses in Wastewater and Surface Water Sam-	W91-10712 5B	Superfund Record of Decision: Commencement
ples by Gene Probe Assay. W91-10665 5A	Superfund Record of Decision: Delaware Sand	Bay/S. Tacoma, WA.
	and Gravel, DE.	W91-10711 5G
Detection of Poliovirus in Water by Direct Iso- lation of the RNA and Hybridization with Gene	W91-10717 5G	Installation of the Westbay Multiport Ground-
Probes.	Cone Penetrometer Tests and HydroPunch	Water Sampling System in Well 699-43-42K Near The 216-B-3 Pond.
W91-10666 5A	Sampling: A Screening Technique for Plume Definition.	W91-10720 7B
Application of a Poliovirus cDNA Probe for the	W91-10794 5A	Status of Ground Water in the 1100 Area.
Detection of Enteroviruses in Water. W91-10667 5A	Fate and Effects of Semivolatile Organic Pollut-	W91-10732 5B
	ants During Anaerobic Digestion of Sludge.	Pacific Salmon at the Crossroads: Stocks at Risk
Detection of Rotaviruses in Water by Gene Probes.	W91-10884 5D	from California, Oregon, Idaho, and Washing- ton.
W91-10668 5A	Volatile Organic Compounds in Two Polluted	W91-10834 8I
Growth of Clinical Isolates of Astrovirus in a	Rivers in Barcelona (Catalonia, Spain). W91-10887 5B	Characterization and Simulation of Rainfall-
Cell Line and the Preparation of Viral RNA.		Runoff Relations for Headwater Basins in West-
W91-10669 5A	Prospecting for Zones of Contaminated Ground- Water Discharge to Streams Using Bottom-Sedi-	ern King and Snohomish Counties, Washington. W91-11592 2A
PCR and Environmental Monitoring: The Way	ment Gas Bubbles.	
Forward. W91-10670 5A	W91-10951 5B	WASTE DISPOSAL  Long Climb to Remediation.
	Continuous Flow Thin-Layer Headspace	W91-10483 5G
Behaviour of Pathogenic Bacteria, Phages and Viruses in Groundwater During Transport and	(TLHS) Analysis. I. Conductometric Determi-	
Adsorption.	nation of Volatile Organic Halogens (VOX) in Tap Water.	Man-Made Garbage Pollution on the Mediterra- nean Coastline.
W91-10672 5B	W91-11256 5A	W91-10569 SB

## WASTEWATER FACILITIES

Regional-Wide Waste Disposal Project on Sea- coast of Enclosed Coastal Sea.	WASTE MANAGEMENT	Detection of Rotaviruses in Water by Gene
W91-10594 5E	Sludge Management by Thermal Conversion to Fuels.	Probes. W91-10668 5A
Application of a Hazard Assessment Research	W91-10706 5D	Salmonella Detection in Sewage Waters Using
Strategy to the Ocean Disposal of a Dredged Material: Overview.	Evaporative Drying of Dredged Material. W91-11000 5D	Fluorescent Antibodies. W91-10687 5D
W91-10740 5E	Pesticide Rinseate Management Plan.	
Role of Biotechnology in the Treatment of Geo-	W91-11195 5G	Flow-Rate Variated HPLC-/EC-Determination of Phenols.
thermal Residual Sludges.	WASTE RECOVERY	W91-11257 5A
W91-10744 5D	Decrease of Pollutant Level of Bleaching Ef-	Quantitative Determination of Acrylonitrile in
Development and Implementation of a Remedial	fluents and Winning Valuable Products by Suc-	an Industrial Effluent by Ambient-Temperature
Investigation Work Plan and Data Management	cessive Flocculation and Microbial Growth. W91-11488 5D	Purge and Trap Capillary GC-MS and by Heated Purge and Trap GC-FID.
System. W91-10799 5G		W91-11336 5A
	WASTE TREATMENT Dutch Approach to Manure Processing.	
Occurrence of Appendix IX Organic Constitu- ents in Disposal Site Ground Water.	W91-10703 5D	Anaerobic Toxicity of Fines In Chemi-thermo- mechanical Pulp Wastewaters: A Batch Assay-
W91-10801 5B	Processing Organic Waste Products to Black	Reactor Study Comparison. W91-11479 5D
Geophysical and Chemical Investigations of	Soil and Organic Fertilizers. W91-10705 5E	High-Performance Liquid Chromatographic
Ground Water at Five Industrial or Waste-Dis- posal Sites in Logan Township, Gloucester		Study on Oxidation Products of Lignin and
County, New Jersey, 1983-87.	Role of Biotechnology in the Treatment of Geo- thermal Residual Sludges.	Humic Substances.
W91-11092 5B	W91-10744 5D	W91-11513 5A
Production, Treatment and Handling of Sewage	Evaporative Drying of Dredged Material.	WASTEWATER DILUTION
Sludge.	W91-11000 5D	Surface Dilution of Round Submerged Buoyant
W91-11116 5D	Removal of Heavy Metals from Sewage Sludge:	Jets. W91-10986 5E
Physical and Chemical Characterization of	State of the Art and Perspectives.	
Sewage Sludge.	W91-11124 5D	WASTEWATER DISPOSAL Environmental Assessment of Wastewater
W91-11117 5D	Improvement of the Quality of Sewage Sludge:	Marine Disposal of Xiaogang Zone, Ningbo.
Methods of Applying Sewage Sludge to Land:	Microbiological Aspects.	W91-10570 SE
A Review of Recent Developments. W91-11119 5E	W91-11125 5D	Assessment of the Environmental Capacity of
	Technical Requirements and Possibilities of In-	Enclosed Coastal Sea.
Alternative Uses of Sludge Other than Agricul-	cineration. W91-11129 5D	W91-10571 5E
tural. W91-11120 5E		Sewage Treatment and Disposal Strategies in
	Liquid Effluents: New Solutions to Old Prob-	Greece.
Effects of Sewage Sludge and Waste Compost on Some Soil Enzymatic Activities Tested in a	lems. W91-11360 5D	W91-10598 5G
Field Experiment.		Surface Dilution of Round Submerged Buoyant
W91-11151 5E	WASTE UTILIZATION  Nitrogen Dynamics of Pulp and Paper Sludge	Jets. W91-10986 5E
Production of Compost from Sewage Sludge in	Amendment to Forest Soils.	
Tokyo.	W91-11510 5E	Assessment of Hydrogeologic Conditions with Emphasis on Water Quality and Wastewater In-
W91-11153 5E	Production of Chironomid Larvae in Culturing	jection, Southwest Sarasota and West Charlotte
Returnable Pesticide Containers: Maine's Depos-	Media of Various Organic Wastes. W91-11526 81	Counties, Florida.
it and Collection System. W91-11191 5G	W91-11320 81	W91-11087 2F
W31-11131	WASTEWATER	Sewage Sludge Treatment and Use: New Devel-
Oregon Pesticide Container Initiative. W91-11192 5E	Study of Campylobacter in Sewage, Sewage Sludge and in River Water.	opments, Technological Aspects and Environ-
W91-11192 5E	W91-10634 5D	mental Effects. W91-11115 5E
Minnesota Waste Pesticide Collection Pilot	Remobilization of Cu from Marine Particulate	
Project. W91-11193 5E	Organic Matter and from Sewage.	Pesticide Rinseate Management Plan. W91-11195 5G
	W91-10923 5B	
Urban Pesticide Waste Management: Strategies for Education and Collection.	WASTEWATER ANALYSIS	Marine Monitoring in Heterogeneous Environ- ments.
W91-11194 5E	Determining Giardiasis Prevalence by Examina-	W91-11264 5A
Waste Disposal Facilities and Community Re-	tion of Sewage. W91-10646 5A	Treatment Technologies for Organochlorine-
sponse: Tracing Pathways from Facility Impacts		Containing Sludges and Concentrates from Ex-
to Community Attitude.	W91-10648 SB	ternal Treatment of Pulp and Paper
W91-11280 5E		Wastewaters. W91-11500 5D
Groundwater Contamination By Anthropogenic		
Organic Compounds From Waste Disposa Sites: Transformations and Behavior.		WASTEWATER FACILITIES Boston's Sewage Outfall.
W91-11378 5E	Concentration of Hepatitis A Virus in Environ- mental Samples.	W91-10485 5D
Hazard Assessment Research Strategy for	W91-10658 5A	Comparison of Pressurized and Gravity Distri-
Ocean Disposal.	Polyvalent Coliphages in Sewage.	bution Systems for Wastewater Treatment.
W91-11551 5E		W91-10845 5D
WASTE DUMPS	Detection of Hepatitis A Virus and Other Enter-	Use of Bacillus thuringiensis var. israelensis to
Assignment of the Class of Hydraulic-Fill Wast	oviruses in Wastewater and Surface Water Sam-	Control the Nuisance Fly Sylvicola fenestralis
Dumps.	ples by Gene Probe Assay.	(Anisopodidae) in Sewage Filter Beds. W91-10890 5D
W91-11285 5I	3 W91-10665 5A	W 21-10920

## WASTEWATER FACILITIES

Fertility of Workers Chronically Exposed to Chemically Contaminated Sewer Wastes. W91-11316 5D	Impact of Titanium Dioxide Waste on Fertiliza- tion in the Sea Urchin Echinometra mathaei. W91-10870 5C	Activity of Peracetic Acid on Sewage Indicator Bacteria and Viruses. W91-10683 5D
Foaming in Activated Sludge Plants: A Survey in Queensland, Australia and an Evaluation of	Effect of Three Primary Treatment Sewage Outfalls on Metal Concentrations in the Fish	Clostridium perfringens, as an Indicator Micro-
Some Control Strategies. W91-11328 5D	Cheilodactylus fuscus Collected Along the Coast of Sydney, Australia.	organism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems. W91-10686 5D
Discoulation of the Property o	W91-10873 5B	
Rise and Fall of the Potomac River Striped Bass Stock: A Hypothesis of the Role of Sewage.	Compositive Physics Chamical Applicate of	Destruction of Faecal Bacteria, Enteroviruses
W91-11529 5C	Comparative Physico-Chemical Analysis of Drinking, Ground and Industrial Waste Water	and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophi-
No. Committee Broader Broader Clark	of Jodhpur.	lic Digestion.
New Storm Water Regulations Require Signifi- cant Compliance Actions by Both Industries and	W91-11083 5B	W91-10688 5D
Municipalities.	Estimation of Trace Metals Levels in Power and	Contribution for the Study of New Pathogenic
W91-11541 5D	Industrial Waste Water of Jodhpur by Differen-	Indicators Removal from W. S. P. in Portugal.
WASTEWATER FARMING	tial Pulse Anodic Stripping Voltammetry.	W91-10689 5D
Agronomic Effects of Land Application of	W91-11084 5A	Dynamics of Non-01 Vibrio cholerae in Experi-
Water Treatment Sludges. W91-11459 4C	Situation of Water Supply in the New Lander of	mental Sewage Stabilization Ponds Under Arid
	the Federal Republic of Germany. W91-11272 5F	Mediterranean Climate. W91-10690 5D
WASTEWATER LAGOONS Superfund Record of Decision: Iron Horse Park,		W91-10090
MA.	Distribution of Fecal Pollution Indicator Bacte-	Waste Stabilization Ponds in Grand Cayman,
W91-10719 5G	ria in Lake Kinneret. W91-11322 5B	Cayman Islands. W91-10691 5D
Studies on the Environmental Persistence of S-		
31183 (Pyriproxyfen): Adsorption onto Organic	Rise and Fall of the Potomac River Striped Bass Stock: A Hypothesis of the Role of Sewage.	Survival of Pathogenic Bacteria in an Adverse
Matter and Potential for Leaching through Soil.	W91-11529 5C	Environment. W91-10692 5D
W91-10831 5B		W91-10092
WASTEWATER MANAGEMENT	Quality of Salmonid Hatchery Effluents During a Summer Low-Flow Season.	Comparative Study on Adsorption Mechanisms
Innovative Subsurface Sewage Management: A	W91-11532 5D	of RNA-F-Specific Coliphages and Poliovirus in
Program to Protect Idaho's Rathdrum Prairie Aquifer.		Activated Sludge Process. W91-10694 5D
W91-11186 5G	WASTEWATER REACTORS Influence of Reactor Mixing Characteristics on	
Minnestels Obested County A Consentius	the Rate of Nitrification in the Activated Sludge	New Developments in Processing of Sludges and Slurries.
Minnesota's Olmsted County: A Cooperative Health Based Perspective on Zoning and Plan-	Process.	W91-10699 5D
ning.	W91-10932 5D	
W91-11187 6B	Anaerobic Treatment of Bleached TMP and	Accumulation of Refractory 4-Nonylphenol During Mesophilic Anaerobic Sludge Stabiliza-
WASTEWATER OUTFALL	CTMP Effluent In the BioPAQ UASB System.	tion.
Assessment of the Environmental Capacity of	W91-11501 5D	W91-10707 5D
Enclosed Coastal Sea. W91-10571 5E	Biotechnological Sulphide Removal from Ef-	Environmental Feasibility of Using Wetlands to
	fluents.	Treat Runoff Pollution.
Coefficient of Pollution (p): The Southern Cali-	W91-11502 5D	W91-10737 5D
fornia Shelf and Some Ocean Outfalls. W91-10874 5B	Anaerobic Degradation of PCP and Phenol In	Role of Biotechnology in the Treatment of Geo-
	Fixed-Film Reactors: The Influence of an Addi- tional Substrate.	thermal Residual Sludges.
Environmentally Desirable Approaches for Reg- ulating Effluents from Pulp Mills.	W91-11512 5D	W91-10744 5D
W91-11504 5G		Aeromonas Species Stabilization Ponds in the
WARPINATED DOLLARS	WASTEWATER RENOVATION Microbiological Methods for Safety Testing of	Arid Region of Marrakesh, Morocco, and Rela-
WASTEWATER POLLUTION  Mathematical Simulation of Pollutant Disper-	Drinking Water Directly Reclaimed from	tion to Fecal-Pollution and Climatic Factors.
sion.	Wastewater.	W91-10842 5D
W91-10488 5B	W91-10613 5A	Comparison of Pressurized and Gravity Distri-
Pollution and Protection of Bohai Bay.	WASTEWATER TREATMENT	bution Systems for Wastewater Treatment.
W91-10522 5B	Boston's Sewage Outfall.	W91-10845 5D
Mariculture and Eutrophication in Jinhae Bay,	W91-10485 5D	Fate and Effects of Semivolatile Organic Pollut-
Korea.	Sewage Treatment and Disposal Strategies in	ants During Anaerobic Digestion of Sludge.
W91-10558 5B	Greece.	W91-10884 5D
Studies on the Situation of Pollution and Coun-	W91-10598 5G	Removal of Acetate from NSSC Sulphite Pulp
termeasures of Control of the Oceanic Environ-	Measures for Purification of the Leachate from	Mill Condensates Using Thermophilic Bacteria.
ment in Zhoushan Fishing Ground: The Largest	'Renseanlage Damhusaen' into Copenhagen	W91-10889 5D
Fishing Ground in China. W91-10559 5C	Waters, to Meet the NPO-Plan. W91-10601 5D	Influence of Reactor Mixing Characteristics on
Incidence and Ecology of Marine Fouling Orga-		the Rate of Nitrification in the Activated Sludge Process.
nisms in the Eastern Harbour of Alexandria,	Distribution of Giardia Cysts in Wastewater. W91-10649 5B	W91-10932 5D
Egypt.		Companying Study and Makamatinal Market
W91-10560 5C	Polyvalent Coliphages in Sewage.	Comparative Study and Mathematical Modeling of Temperature, Light and Growth of Three
Aeromonas Species Stabilization Ponds in the	W91-10663 5A	Microalgae Potentially Useful for Wastewater
Arid Region of Marrakesh, Morocco, and Rela-	UV Disinfection of Secondary Effluents from	Treatment.
tion to Fecal-Pollution and Climatic Factors. W91-10842 5D	Sewage Treatment Plants. W91-10681 5D	W91-10937 5D
		Anaerobic Treatability of a Phenolic Coal Con-
Modification of Benthic Community Structure	F-Specific RNA Bacteriophages as Model Vi-	version Wastewater After Diisopropyl Ether
in Response to Acid-Iron Wastes Discharge. W91-10869 5C	ruses in UV Disinfection of Wastewater. W91-10682 5D	Extraction. W91-10939 5D
		30

Embertion of Euli Coals Assisted Chidas Con	Shales Beauties in Amin by Grand 198	N D 1
Evaluation of Full Scale Activated Sludge Sys-	Sludge Recycling in Agriculture Compared with	New Developments in Sampling Sludge Treated
tems Utilizing Powdered Activated Carbon Addition with Wet Air Regeneration.	Other Disposal Methods in France. W91-11137 5E	Soils.
W91-11099 5D	W91-11137 5E	W91-11158 5A
471-11037	Use of Municipal Sewage Sludge in Agriculture:	Chemical Properties of Sewage Sludges Pro-
Sewage Sludge Treatment and Use: New Devel-	The Role of the Water Authorities.	duced in the Valencian Area (Spain).
opments, Technological Aspects and Environ-	W91-11138 5D	W91-11159 5A
mental Effects.		W.71-11107
W91-11115 5E	Examples of Agricultural Use of Residual	Microbial Biomass and Biological Activities in
Bradustian Treatment and Handling of Course	Sludge.	an Acid Sandy Soil Treated with Sewage Sludge
Production, Treatment and Handling of Sewage Sludge.	W91-11139 5D	or Farmyard Manure in a Long Term Field
W91-11116 5D	Clades Testered and Timber City 111-4-1	Experiment.
W91-11110 3D	Sludge Treatment and Tipping Site 'Hartel- mond'.	W91-11160 5E
Physical and Chemical Characterization of		
Sewage Sludge.	W91-11140 5D	Slurry and Sludge Spreading Methods.
W91-11117 5D	Stabilization of Sewage Sludge and Its Disinfec-	W91-11161 5E
	tion According to Specific Requirements: Two-	
Sludge Reduction Possibilities as Demonstrated	Stage Anaerobic/Aerobic Operating Tech-	Selective Concentration of Lead(II) Chloride
by the Chemolysis Process Dow Stade GmbH.	niques.	Complex With Liquid Anion-Exchange Mem-
W91-11118 5D	W91-11141 5D	branes.
Methods of Applying Sewage Sludge to Land:		W91-11247 5D
A Review of Recent Developments.	Ban on Phosphorus in Detergents: The Effects	Delaiferate to Theoretic Sell Bernie
W91-11119 5E	on the Phosphorus Contents of Swiss Sewage	Denitrification by Thermophilic Soil Bacteria
	Sludges and on the Efficiency of Phosphorus	With Ethanol as Substrate in a USB Reactor.
Alternative Uses of Sludge Other than Agricul-	Elimination by Sewage Treatment Plants.	W91-11254 5D
tural.	W91-11142 5D	Hea of a Backfinsh Tachainna in Con-
W91-11120 5E	A Lie The Lille Mark to the Point of the	Use of a Backflush Technique in Cross-flow
Odova Backlama with Commer Classes	Aerobic-Thermophilic Methods for Disinfecting	Microfiltration for Treating Natural Water and
Odour Problems with Sewage Sludge.	and Stabilizing Sludge.	Filter Backwash Wastewater in Water Works.
W91-11121 5D	W91-11143 5D	W91-11270 5F
Modern Sludge Management: The Manager's	Chemolysis Process of Dow Stade GMBH.	Effect of a Chalating Agent (DYPA) on Assess
Choice.	W91-11144 5D	Effect of a Chelating Agent (DTPA) on Anaero- bic Wastewater Treatment in an Upflow Sludge
W91-11122 5D	W31-11144 3D	Blanket Filter.
***************************************	Extraction of Heavy Metals from Sludges and	
Pathway Analysis of Selected Organic Chemi-	Muds by Magnetic Ion-Exchange.	W91-11277 5D
cals from Sewage to Agricultural Soil.	W91-11145 5D	Use of Ligand-Modified Micellar-Enhanced Ul-
W91-11123 5B		trafiltration in the Selective Removal of Metal
D 1 677 - W-1 6 - 6 - 61-1	Wet Oxydation as the Alternative for Sewage	Ions from Water.
Removal of Heavy Metals from Sewage Sludge:	Sludge Treatment.	W91-11318 5D
State of the Art and Perspectives. W91-11124 5D	W91-11146 5D	W 51-11516
W91-11124 5D		Laboratory Studies of Virus Survival During
Improvement of the Quality of Sewage Sludge:	Heavy Metal Speciation in Sewage Sludge Fol-	Aerobic and Anaerobic Digestion of Sewage
Microbiological Aspects.	lowing a Phyto-Dewatering Treatment.	Sludge.
W91-11125 5D	W91-11147 5D	W91-11319 5D
	Madifications of Come Physical Properties in	
Organic Substances in Soils and Plants after	Modifications of Some Physical Properties in	Modeling the Upflow Anaerobic Sludge Bed-
Intensive Applications of Sewage Sludge.	Two Compost-Amended Italian Soils. W91-11148 5E	Filter System: a Case with Hysteresis.
W91-11126 5E	W91-11148 5E	W91-11321 5D
High Passage Douglasing with Balance Condi	Composting Raw Sewage Sludge in the Absence	
High-Pressure Dewatering with Polymer Condi- tioning as a Prerequisite for the Energy-Inde-	of Bulking Agents.	Colour Removal from Textile Effluents by Ad-
pendent Incineration of Sewage Sludge.	W91-11149 5E	sorption Techniques.
W91-11127 5D		W91-11323 5D
W71-1112/	Use of Sewage Sludge on Agricultural Land:	
Sludge Dewatering Technology in Perspective.	Impact on Soil Fauna.	1-Naphthalenesulfonic acid and Sulfate as Sulfur
W91-11128 5D	W91-11150 5E	Sources for the Green Alga Scenedesmus obli-
		quus.
Technical Requirements and Possibilities of In-	Effects of Sewage Sludge and Waste Compost	W91-11326 5D
cineration.	on Some Soil Enzymatic Activities Tested in a	
W91-11129 5D	Field Experiment.	Foaming in Activated Sludge Plants: A Survey
Environmental Aspects of Sludge Incineration:	W91-11151 5E	in Queensland, Australia and an Evaluation of
Overview.	Existing Conditions for Assignitured Hellington	Some Control Strategies.
W91-11130 5E	Existing Conditions for Agricultural Utilization of Sewage Sludge Compost in Japan.	W91-11328 5D
35	W91-11152 5E	Application of Physics chamical Tours
Sewage Sludge Incineration and Utilization of	W91-11132 3E	Application of Physicochemical Treatment to ar
Energy.	Production of Compost from Sewage Sludge in	Overloaded Sewage Works.
W91-11131 5D	Tokyo.	W91-11357 5D
	W91-11153 5E	Comparison of Alternative Operating Modes or
Sludge Treatment in Amsterdam: Economical,		the Halifax Activated-Sludge Plant.
Technical and Environmental Experiences.	Beneficial Utilization of Incinerated Ash and	
W91-11132 5D	Melted Slag.	W91-11359 5D
Status Report on Environment Canada's Oil	W91-11154 5E	Design of Sewage-Treatment Plants in Brisbane
From Sludge Technology.		Australia.
W91-11133 5D	Sludge Dewatering: First Membrane Filterpress	W91-11361 5D
	Plant in the Netherlands Operational.	772-11301
Thermophilic Aerobic Stabilisation.	W91-11155 5D	Study on Triple-Membrane-Separator (TMS)
W91-11134 5D	Sludge Studies on Sludge Management: Strate-	Process to Treat Aqueous Effluents Containing
		Uranium.
Influences on the Mechanical Properties of	gic Studies on Sludge. W91-11156 5D	W91-11367 5D
Sewage Sludge for Disposal to Landfill.	W71-11130	
W91-11135 5D	Studies for a Simultaneous Use of Liquid	Removal of Heavy Metals and Other Cations
Environmental Aspects of Landfilling Sludge.	Manure and Sewage Sludge.	From Wastewater Using Zeolites.
W91-11136 5E	W91-11157 5E	W91-11369 5D

#### WASTEWATER TREATMENT

Treatment of Waste Water From Wet Lime(Stone) Flue Gas Desulfurization Plants With Aid of Crossflow Microfiltration.	Membrane Filtration Combined with Biological Treatment for Purification of Bleach Plant Ef- fluents. W91-11490 5D	Aerobic and Anaerobic Biofiltration in an Aqua- culture Unit-Nitrite Accumulation as a Result of Nitrification and Denitrification. W91-11547 5D
Synthesis and Decomposition of Novel Organo- phosphorus Complexants. W91-11372 5D	Treatment of Pulp-Bleaching Effluents by Activated Sludge, Precipitation, Ozonation and Irra-	Design and Performance of the BIOFISH Water Recirculation System. W91-11548 5D
W91-113/2	diation. W91-11491 5D	W91-11548 5D
Biodegradation of Benzene and a BTX Mixture	#31-11431 3D	WASTEWATER TREATMENT FACILITIES
Using Immobilized Activated Sludge. W91-11381 5D	Investigation of Anaerobic Removal and Degra- dation of Organic Chlorine from Kraft Bleach- ing Wastewaters.	Environmental Assessment of Wastewater Marine Disposal of Xiaogang Zone, Ningbo. W91-10570 5E
Activated Sludge Process to Reduce the Pollu-	W91-11492 5D	
tion Load of a Dye-Industry Waste. W91-11455 5D	0: : 6 N .: . D1 10 64	Rectangular Clarifiers Should Be Considered.
W31-11433	Criteria for Nutrient-Balanced Operation of Ac- tivated Sludge Process.	W91-11223 5D
Sewage Treatment with Plants. W91-11466 5D	W91-11493 5D	Case for Circular Clarifiers.
	Nitrogen and Phosphorus Limits for Nutrient	W91-11224 5D
Forest Industry Wastewaters. W91-11467 5D	Deficient Industrial Wastewaters. W91-11494 5D	WASTEWATER UTILIZATION Trickle Irrigation of Sunflower With Municipal
Process Internal Measures to Reduce Pulp Mill	Conductivity for Nutrient Control In CTMP	Wastewater. W91-11435 3F
Pollution Load.	Conductivity for Nutrient Control In CTMP Wastewater Treatment.	
W91-11473 5G	W91-11495 5D	Agronomic Effects of Land Application of Water Treatment Sludges.
Effects of Chlorination Conditions On the AOX	Practical Experience with Biological Removal	W91-11459 4C
and Chlorinated Phenol Content of Kraft Bleach Plant Wastewaters.	of Phosphorus from Pulp and Paper Mill Ef-	WATER AT A CATTON
W91-11474 5D	fluents.	WATER ALLOCATION Negotiation Techniques to Resolve Western
Closing Paper Mill Whitewater Circuits by In-	W91-11496 5D	Water Disputes.
serting an Anaerobic Stage with Subsequent	Biological Dehalogenation of Kraft Mill	W91-10817 6E
Treatment. W91-11477 5G	Wastewaters. W91-11497 5D	Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes
The Providence of the American Trans	Factors Affecting the Removal and Discharge	and Failures.
Future Perspectives for the Anaerobic Treat- ment of Forest Industry Wastewaters.	of Organic Chlorine Compounds at Activated	W91-11008 6E
W91-11478 5D	Sludge Treatment Plants.	WATER ANALYSIS
Anaerobic Toxicity of Fines In Chemi-thermo-	W91-11498 5D	EC Bathing Water Virological Standard: Is It
mechanical Pulp Wastewaters: A Batch Assay-	Treatability of Bleached Kraft Pulp and Paper	Realistic.
Reactor Study Comparison.	Mill Wastewaters In a New Zealand Aerated Lagoon Treatment System.	W91-10622 5A
W91-11479 5D	W91-11499 5D	Production and Control of Reference Materials
Anaerobic Biodegradability and Methanogenic		for Water Microbiology. W91-10623 5A
Toxicity of Pulping Wastewaters. W91-11480 5D	Treatment Technologies for Organochlorine- Containing Sludges and Concentrates from Ex-	
	ternal Treatment of Pulp and Paper	Preliminary Statistical Assessment of UK Water Quality Control Trials.
Treatment and Detoxification of Aqueous Spruce Bark Extracts by Aspergillus niger.	Wastewaters.	W91-10624 5G
W91-11481 5D	W91-11500 5D	Committee Caladana A. Willada I. D. L
Effect of NSSC Spent Liquor on Granule For-	Anaerobic Treatment of Bleached TMP and	Surveillance Solutions to Microbiological Prob- lems in Water Quality Control in Developing
mation and Specific Microbial Activities In	CTMP Effluent In the BioPAQ UASB System. W91-11501 5D	Countries. W91-10625 5G
Upflow Anaerobic Reactors. W91-11482 5D	Biotechnological Sulphide Removal from Ef-	
	fluents.	Evaluation of Fecal Enterococci Isolation Media to Indicate Fecal Pollution in Chlorinated
Thermophilic Anaerobic Treatment of Sulfate- Rich Pulp and Paper Integrate Process Water.	W91-11502 5D	Water.
W91-11483 5D	Thermocatalytic and Chemical Treatment of	W91-10626 5F
Biodegradability of Chlorinated Organic Com	Lignin-Aluminium Sludge and Utilization of the	Coliform Bacteria in Drinking Water from
Biodegradability of Chlorinated Organic Com- pounds In Pulp Bleaching Effluents.	Resulting Adsorbent-Coagulant.	South Bavaria: Identification by the API 20E-
W91-11484 5D	W91-11503 5D	System and Resistance Patterns.
Oxic Fluidized-Bed Treatment of Dichlorophen-	Activated Sludge Treatment of Kraft Mill Ef-	W91-10627 5F
ols.	fluents from Conventional and Oxygen Bleach- ing.	Effect of Heat Shock on Recovery of Escheri-
W91-11485 5D	W91-11511 5D	chia coli from Drinking Water. W91-10628 5F
Treatment of Bleaching Effluents In Aerobic/	Anaerobic Degradation of PCP and Phenol In	
Anaerobic Fluidized Biofilm Systems. W91-11486 5D	Fixed-Film Reactors: The Influence of an Addi-	Bacteriological Suitability of Water from Basrah Wells for Drinking.
Onset of Lignin-Modifying Enzymes, Decrease	tional Substrate. W91-11512 5D	W91-10629 5A
of AOX and Color Removal by White-Rot		Biodegradable Dissolved Organic Carbon
Fungi Grown on Bleach Plant Effluents.	Quality of Salmonid Hatchery Effluents During a Summer Low-Flow Season.	(BDOC) Content of Drinking Water and Poten-
W91-11487 5D	a Summer Low-Flow Season. W91-11532 5D	tial Regrowth of Bacteria. W91-10630 5F
Decrease of Pollutant Level of Bleaching Ef-		
fluents and Winning Valuable Products by Suc- cessive Flocculation and Microbial Growth.	Pre-hydrolyzed Aluminum Hydroxide and Iron Hydroxide in Activated Sludge Treatment.	Study of Campylobacter in Sewage, Sewage Sludge and in River Water.
W91-11488 5D	W91-11539 5D	W91-10634 5D
Treatment of Bleach-Plant Effluents with Mem- brane Filtration and Sorption Techniques.	Managing Toxic Substances in Municipal Wastewater Treatment Plants.	Enumeration of Motile Aeromonas in Valencia Coastal Waters by Membrane Filtration.
W91-11489 5D	W91-11540 5D	W91-10636 5B

Most Probable Number Method for the Enu-	by Flow Injection Analysis with Chemilumines-	Determination of Nitroaromatics and Nitramines
meration of Legionella Bacteria in Water. W91-10640 5A	cence Detection. W91-10773 2K	in Ground and Drinking Water by Wide-Bore Capillary Gas Chromatography.
Occurrence of Cryptosporidium spp. Oocysts in	Spectrophotometric Determination of Nitrite in	W91-11262 5A
Scottish Waters, and the Development of a	Polluted Waters Using 3-Nitroaniline.	Preconcentration of Hydrophilic and Hydropho-
Fluorogenic Viability Assay for Individual Cryptosporidium Oocysts.	W91-10823 5A	bic Pesticides from Aqueous Solutions and Ex- traction of Residues Using the Polymeric Sor-
W91-10645 5B	Simultaneous Ultraviolet Spectrophotometric Determination of Nitrate and Nitrite in Water.	bent Wofatit Y 77.
Occurrence and Viability of Giardia spp. Cysts in UK Waters.	W91-10824 5A	W91-11305 3A
W91-10647 5B	Rapid Preconcentration Method for Multiele-	Comparison of Amperometric and UV-Spectro- photometric Monitoring in the HPLC Analysis
Interrelations Between Amoebae and Bacteria in	ment Analysis of Natural Freshwaters.	of Pesticides.
the Moselle River, France. W91-10650 5B		W91-11306 5A
Virological Investigation of the River Elbe.	Chromatographic Separation of Arsenic Species with Sodium Bis(trifluoroethyl)dithiocarbamate	Multi-Residue-Analysis of Pesticides by HPLC after Solid Phase Extraction.
W91-10652 5B	Chelation. W91-10894 5A	W91-11307 5A
Virological Quality of Recreational Waters in		Application of HPLC Column-Switching in Pes-
the Netherlands.	Development of an Enzyme-Linked Immunosor- bent Assay for Geosmin.	ticide Residue Analysis.
W91-10653 5B	W91-10921 5F	W91-11308 5A
Improvement of the Zeta-Plus Filter Method for		Analysis of 10 Selected Herbicides in Water.
Concentration of Viruses from Water. W91-10655 5A	Voltammetric Determination of the Complexa- tion Parameters of Zinc in Marine and Estuarine	W91-11311 5A
Rotavirus Detection: A Problem that Needs	Waters.	Strategy for Pesticide Control in Ground Water and Drinking Water.
Concentration.	W91-10924 2K	W91-11312 5A
W91-10656 5A	Measurement of the Different Forms of Zinc in	
Concentration of Hepatitis A Virus in Environ-	Narragansett Bay Water Based on the Rate of Uptake by a Chelating Resin.	Solid-Phase Extraction for Multi-Residue Analy- sis of Some Triazole and Pyrimidine Pesticides
mental Samples. W91-10658 5A	W91-10926 2K	in Water.
	Analysis of Halogenated Acetic Acids in Dutch	W91-11313 5A
Adsorption of Viruses by Diatomaceous Earth Coated with Metallic Oxides and Metallic Per-	Drinking Water.	Simple Spectrophotometric Determination of
oxides.	W91-10938 5F	Endosulfan in River Water and Soil. W91-11314 5A
W91-10659 5A	Pesticides and Drinking Water Information: A	
Detection of Rotavirus in South African Waters:	Perspective from EPA's National Pesticide	Behavior of the Fungicide MBAMT in Water. W91-11315 5A
A Comparison of a Cytoimmunolabelling Tech- nique with Commercially Available Immunoas-	Survey. W91-11173 5D	
says.	Use of 2,2-Dimethoxypropane for the Direct	New Standards for the Determination of Geos- min and Methylisoborneol in Water by Gar
W91-10660 5A	Gas Chromatographic-Mass Spectrometric De-	Chromatography/Mass Spectroscopy.
Difficulty of Using Coliphages as 'Indicators'	termination of Some Organic Compounds in Water.	W91-11329 5A
and 'Index' Organisms. W91-10661 5A	W91-11245 5A	Coliphage and Bacteriophage as Indicators of
Occurrence of Male-Specific and Somatic Bac-	Determination of Trace Levels of Sulphate in	Recreational Water Quality. W91-11334 5A
teriophages in Polluted South African Waters.	Water Using Flow-Injection and In-Line Pre-	
W91-10662 5B	concentration.	Low Cost Flow Injection Analysis for Cadmium Using 2-(2-benzothiazolylazo) -4,5-Dimethyl
Direct Detection of Enteropathogenic Bacteria	W91-11246 2K	phenol.
in Estuarine Water Using Nucleic Acid Probes. W91-10664 5A	Continuous Flow Thin-Layer Headspace	W91-11379 5A
	(TLHS) Analysis. I. Conductometric Determi- nation of Volatile Organic Halogens (VOX) in	Measuring Low Radon Levels in Drinking
Detection of Poliovirus in Water by Direct Iso- lation of the RNA and Hybridization with Gene	Tap Water.	Water Supplies.
Probes.	W91-11256 5A	W91-11463 5A
W91-10666 5A	Flow-Rate Variated HPLC-/EC-Determination	Latex Agglutination for the Detection of Cam
Application of a Poliovirus cDNA Probe for the	of Phenols. W91-11257 5A	pylobacter Species in Water. W91-11465 5A
Detection of Enteroviruses in Water. W91-10667 5A		
	Capillary Column Gas Chromatography With Nitrogen-Phosphorus Detection for Determina-	WATER AVAILABILITY Microclimatological Investigations in the Tropi
Detection of Rotaviruses in Water by Gene Probes.	tion of Nitrogen-and Phosphorus-Containing	cal Alpine Scrub of Maui, Hawaii: Evidence fo
W91-10668 5A	Pesticides in Finished Drinking Waters: Collabo- rative Study.	a Drought-Induced Alpine Timberline. W91-10878
Growth of Clinical Isolates of Astrovirus in a	W91-11259 5A	
Cell Line and the Preparation of Viral RNA. W91-10669 5A	Direct Aqueous Injection-Liquid Chromatogra-	WATER BIRDS Succession of Benthic Assemblages in Wild Bir
PCR and Environmental Monitoring: The Way	phy With Post-Column Derivatization for De-	Park, a Sanctuary Established on Reclaime
PCR and Environmental Monitoring: The Way Forward.	termination of N-Methylcarbamoyloximes and N-Methylcarbamates in Finished Drinking	Land in Osaka Port. W91-10606 22
W91-10670 5A	Water: Collaborative Study.	
Phosphorus in the Truckee River Between Vista		Dioxin Contamination and Growth and Deve
and Patrick, Storey and Washoe Counties,	Liquid Chromatographic Determination of Gly-	opment in Great Blue Heron Embryos. W91-10837 5
Nevada, August 1984. W91-10763 5A	phosate and Aminomethylphosphonic Acid	
Determination of Subnanomolar Levels of	(AMPA) in Environmental Water: Collaborative Study.	Subchronic Hepatotoxicity of Selenomethionin Ingestion in Mallard Ducks.
Iron(II) and Total Dissolved Iron in Seawater		W91-10838 5

5C

#### WATER CHEMISTRY

WATER CHEMISTRY	Adoption of Water-Savings Practices by Irriga-	Analysis of Large Scale Water Distribution Sys-
Iodine Chemistry in the Water Column of the Chesapeake Bay: Evidence for Organic Iodine	tors in the High Plains. W91-10821 3F	tems. W91-10983 5F
Forms.		
W91-10496 2L	Watershed-Based Conservation Programs is the Public Getting Its Money's Worth.	WATER DISTRICTS  Channel Tunnel and Its Impact on the Folkes-
Water Exchange and Transport of Matter in the	W91-11044 6C	tone and District Water Company.
Seto Inland Sea.	Soil Conservation Service and Extension: Coop-	W91-11363 4C
W91-10527 2L	erating to Enhance Services (MES Portion). W91-11170 6E	WATER ENTITLEMENTS
Fate of Silicate Minerals in a Peat Bog.	W71-111/0	Transferability of Water Entitlements in Austra-
W91-10789 2H	Coordinating Roles and Services: Soil Conserva-	lia.
Groundwater Flow and the Metal Content of	tion Service and Extension Service.	W91-10850 6E
Peat.	W91-11171 6E	WATER EROSION PREDICTION PROJECT
W91-10902 2F	Design and Performance of the BIOFISH Water Recirculation System.	WEPP: A New Generation of Erosion Predic-
Hydrogeochemical Processes Controlling Sub-	W91-11548 5D	tion Technology.
surface Transport from an Upper Subcatchment of Walker Branch Watershed During Storm	Soil and Moisture Conservation Technologies:	W91-10511 2J
Events. 1. Hydrologic Transport Processes.	Review of Literature.	WEPP: Soil Erodibility Experiments for Range-
W91-10907 5B	W91-11565 4D	land and Cropland Soils. W91-10512 2J
Nitrate Removal by Denitrification in Alluvial	WATER CONVEYANCE	
Ground Water: Role of a Former Channel.	Analysis of Large Scale Water Distribution Sys-	WATER EXCHANGE
W91-10909 5B	tems.	Water Exchange and Transport of Matter in the
W 71-10707	W91-10983 5F	Seto Inland Sea.
Riparian Zone as a Source of Phosphorus for a		W91-10527 2L
Groundwater-Dominated Lake.	WATER COSTS	
W91-10931 2H	Willingness-to-Pay for Protection of Water Sup-	WATER HYACINTH
	plies in Four Massachusetts' Towns.	Influence of Leaf Leachate-Enriched Water of
Comparative Physico-Chemical Analysis of	W91-11056 6C	Neem (Azadirachta indica A. Juss.) and Shirish
Drinking, Ground and Industrial Waste Water	WATER CURRENTS	(Albizzia lebbek Benth.) on the Growth of Eich-
of Jodhpur.	Summer Circulation in the Kingston Basin, Lake	hornia crassipes (Mart.) Solms.
W91-11083 5B	Ontario.	W91-11449 2I
Rainwater and Throughfall Chemistry in a	W91-10978 2H	WATER LAW
'Terre Firme' Rain Forest: Central Amazonia.		FACTA 1990 Conservation and Environmental
W91-11218 2B	Regulatory Influence of Water Current on Algal	Highlights.
	Colonization in an Unshaded Stream at Shillong (Meghalaya, India).	W91-10507 5G
Multicomponent Kinetic Analysis of Iron Speci-	W91-11451 2E	
ation in Humic Lake Tjeukemeer: Comparison	W)1-11431	Negotiation Techniques to Resolve Western
of Fulvic Acid from the Drainage Basin and Lake Water Samples.	WATER DEFICIT	Water Disputes.
W91-11339 2H	Hydrological Aspects of the 1988 Drought in	W91-10817 6E
W 71-11337	Illinois.	Changing Dynamics of Interest Representation
Assessing the Response of Emerald Lake, an	W91-10810 2B	in Water Resources Management.
Alpine Watershed in Sequoia National Park,	Effects of the 1988 Drought on Water Resources	W91-11007 6E
California, to Acidification during Snowmelt by	in Wisconsin.	W91-11007
Using a Simple Hydrochemical Model.	W91-11108 2E	Legal Regimes for Interstate Water Allocation
W91-11594 5C		in the Western United States: Some Successes
WATER CIRCULATION	WATER DEMAND	and Failures.
Circulation and Pollutant Dispersion in Masan-	Water Control Systems and the Traditional Fes-	W91-11008 6E
Jinhae Bay of Korea.	tival at Miyawaki, on the Seto Inland Sea. W91-10591 3F	Winner of the Print American Print No. 1 No. 1 No. 1 No. 1
W91-10526 5B	W 71-10371 3F	Wisconsin's Risk Assessment Based Numerical Groundwater Standards Program.
	Water Management Issues for the Nineties.	
Formation of Oxygen-Deficient Water Mass in	W91-10807 6D	W91-11183 5G
Omura Bay.	The state of the s	Past, Present, and Future of Water Resources
W91-10592 5B	Transferability of Water Entitlements in Austra- lia.	Management In the United States.
Flow Control Technology for Enhancement and	W91-10850 6E	W91-11207 4A
Diverse Use of the Marine Environment.		
W91-10607 2L	Water Rate Structure for Demand Management	Tensions Between Water Legislation and Cus-
20	in the Regional Municipality of Waterloo.	tomary Rights.
Estimation of Phosphorus Exchange Between	W91-11049 6C	W91-11383 6E
Littoral and Pelagic Zones During Nighttime	Water Market in the Southern Front Range of	Regulation of Interbasin Transfers and Con-
Convective Circulation.	Colorado.	sumptive Uses from the Great Lakes.
W91-10863 2H	W91-11055 6D	W91-11384 6E
Summer Circulation in the Kingston Basin, Lake		
Ontario.	Decision Support System for Water Transfer	Agency Autonomy in Transboundary Resource
W91-10978 2H	Evaluation.	Management: The United States Section of the
	W91-11226 6A	International Boundary and Water Commission,
Three-Dimensional Numerical Modelling of	Selection of the Operating Regime of the Onega-	United States and Mexico.
Wind-Driven Circulation in a Shallow Homoge-	Svir' Water System Under Conditions of In-	W91-11388 6E
neous Lake.	creasing Water Consumption.	Evolution of Nevada's Water Laws, as Related
W91-10992 2H	W91-11288 6D	to the Development and Evaluation of the
WATER CONSERVATION	Student Water Lice	State's Water Resources, from 1866 to about
Water Use Reductions from Retrofitting Indoor	Student Water Use. W91-11460 6D	1960.
Water Fixtures.	1171-11400 OD	W91-11573 6E
W91-10811 6D	WATER DISTRIBUTION	
	Causes of Waterborne Outbreaks in the United	Photographs Written Historical and Descriptive
Residential Water Conservation: Casa Del Agua.	States.	Data.
W91-10814 3D	W91-10616 5B	W91-11577 6E

WATER LEVEL Aquatic Macroinvertebrates of the St. Francis Sunken Lands in Northeast Arkansas.	Tensions Between Water Legislation and Cus- tomary Rights. W91-11383 6E	Seagrass-Mangrove Ecosystems Management: A Key to Marine Coastal Conservation in the ASEAN Region.
W91-10844 4C		W91-10539 5G
Great Lakes Levels and Flows Under Natural	WATER PERMITS Regulation of Interbasin Transfers and Con-	Present State of Environmental Pollution in
and Current Conditions. W91-11022 2H	sumptive Uses from the Great Lakes. W91-11384 6E	Coastal Sea Area and Measures for Protection. W91-10540 5B
1987-89 Drop in Great Lakes Water Levels,	WATER BOLLOW	Comment of Posts and Marine Francisco
Causes and Effect. W91-11023 2H	WATER POLICY Do We Have a National Water Policy. W91-10505 6B	Summary of Ports and Marine Environment Im- provement Work and Example of Latest Meas- ures in Seto Inland Sea.
Fluctuating Water Levels in the Great Lakes-St.		W91-10545 5G
Lawrence River Basin: An Evaluation Frame-	Water Futures. W91-10506 6B	Recovery of Aquatic Animals in Dokai Bay,
work for the Analysis of Potential Actions.		Northern Kyushu, Japan.
W91-11026 6B	FACTA 1990 Conservation and Environmental Highlights.	W91-10550 5G
Great Lakes Water Levels Management: Relaxing the 'Policy Trap'.	W91-10507 5G	Study on Model Reference Adaptive Water Pol-
W91-11027 6A	Water Management Issues for the Nineties.	lution Control in Enclosed Coastal Sea. W91-10567 5G
Fluctuating Great Lakes Water Levels: Progress	W91-10807 6D	
and Opportunities.	Iterative Evaluation of a Lake Water Quality	Countermeasures Against Water Pollution in Enclosed Coastal Seas in Japan.
W91-11032 6A	Management Program.	W91-10572 5G
Fluctuating Water Levels: An Issue Manage-	W91-10808 5G	Environmental Management of the Seto Inland
ment Approach. W91-11033 6B	Dynamics of Water Policy.	Sea.
	W91-11212 6E	W91-10573 5G
So What. Findings and Recommendations from the Lake Levels Study.	Regulation of Interbasin Transfers and Con-	International Programme for the Protection of
W91-11037 6A	sumptive Uses from the Great Lakes. W91-11384 6E	Semi-Enclosed Sea: The Mediterranean Action Plan.
Response of Water Level in a Well to a Time		W91-10574 5G
Series of Atmospheric Loading Under Confined	Regulatory Requirements for Pulp and Paper Mill Effluent Control: Scientific Basis and Con-	Environmental Management of the Puge
Conditions. W91-11236 2F	sequences.	Sound.
Concept of Evaporation from Fresh and Saline	W91-11470 5G	W91-10577 5G
Water Bodies.	Goals, Regulations and Information Needs for	Sea and Fresh Water Conservation.
W91-11244 2D	Wastewater Discharge ManagementAn Ameri- can Perspective.	W91-10578 5C
Geomorphic, Geographic, and Hydrographic	W91-11471 5G	Controlling Effect of the Planned Managemen
Basis for Resolving the Mono Lake Controver- sy.	WATER POLLUTION	of the Environment in the Kagoshima Bay of the Pollutant Load.
W91-11442 6G	Health-Related Water Microbiology 1990.	W91-10579 5C
Hydrologic Characteristics of the Great Salt	W91-10612 5F	Personal Computer System Supporting Water
Lake, Utah: 1847-1986. W91-11597 2H	Simultaneous Ultraviolet Spectrophotometric Determination of Nitrate and Nitrite in Water.	Quality Management in Eutrophicated Bay. W91-10582 50
WATER LEVEL FLUCTUATIONS	W91-10824 5A	Management of the Marine Environment is
Effect of Coastal Sea Level Forcing on Indian	Tar Balls on Ibeno-Okposo Beach of South-East	
River Bay and Rehoboth Bay, Delaware. W91-10494 2L	Nigeria.	W91-10583 50
	W91-10876 5B	Nongovernmental Educational Activities fo
WATER MANAGEMENT Report of the River Master of the Delaware	Denitrification in Laboratory Sand Columns: Carbon Regime, Gas Accumulation and Hy-	Environmental Protection. W91-10588 50
River, for the Period December 1, 1988-Novem-	draulic Properties.	
ber 30, 1989. W91-10765 4A	W91-11330 5G	National Estuary Program and Public Involve ment.
	WATER POLLUTION CONTROL	W91-10590 50
Water Management Issues for the Nineties. W91-10807 6D	Ground Water: How Contaminated. W91-10484 5G	Regional-Wide Waste Disposal Project on Ses
Transferability of Water Entitlements in Austra-		coast of Enclosed Coastal Sea.
lia.	Pollution and Protection of Bohai Bay. W91-10522 5B	W91-10594 51
W91-10850 6E		Water Quality Purification System for the En
Groundwater Management Model for Salt Lake		closed Sea Area. W91-10596 50
County, Utah with Some Water Rights and Water Quality Considerations.	W91-10523 5G	
W91-10911 4B	Evaluation of Primary Production Loads and	Sewage Treatment and Disposal Strategies in Greece.
Comprehensive Water Management Strategy:	Their Control in Enclosed Seas.	W91-10598 50
Credit River Watershed.	W91-10524 3G	Measures for Purification of the Leachate from
W91-11043 6A	North Sea Strategies.	'Renseanlage Damhusaen' into Copenhage
Water Management in the 21st Century.	W91-10530 5G	Waters, to Meet the NPO-Plan. W91-10601 5I
W91-11206 4A	5-Year Scientific Research Programme for Man-	
Past, Present, and Future of Water Use and	aging Coastal Seas. W91-10531 2L	Legal System and Management of Souther France Lagoons.
Management. W91-11209 4A		W91-10611 50
Future Water Management Problems: The Fed-	Water Quality Assessment and Protection Meas-	
eral Role In Their Solution.	of Thermaikos (NE Mediterranean Sea).	Quality Control Trials.
W01-11210 4A	W91-10534 5G	W91-10624 50

## WATER POLLUTION CONTROL

Surveillance Solutions to Microbiological Prob- lems in Water Quality Control in Developing Countries. W91-10625 5G	Funding Groundwater Protection Programs: Iowa's Groundwater Protection Fund. W91-11179 5G	Decrease of Pollutant Level of Bleaching Effluents and Winning Valuable Products by Successive Floculation and Microbial Growth.
W91-10625 5G	Central Platte Natural Resources District's	W91-11488 5D
Permitting Nonpoint Sources: Programs, Provisions, Problems and Potential. W91-10730 5G	Groundwater Management Program. W91-11190 5G	Nitrogen and Phosphorus Limits for Nutrient Deficient Industrial Wastewaters.
W91-10/30	Returnable Pesticide Containers: Maine's Depos-	W91-11494 5D
Ambient Water Quality Criteria for Ammonia (Saltwater)-1989. W91-10750 5G	it and Collection System. W91-11191 5G	Environmentally Desirable Approaches for Regulating Effluents from Pulp Mills.  W91-11504 5G
	Oregon Pesticide Container Initiative.	W91-11504 5G
Buffer Strips to Protect Water Supply Reser-	W91-11192 5E	Rise and Fall of the Potomac River Striped Bass
voirs: A Model and Recommendations. W91-10816 5G	Minnesota Waste Pesticide Collection Pilot	Stock: A Hypothesis of the Role of Sewage. W91-11529 5C
Bacteriophages as Model Viruses in Water Qual-	Project.	
ity Control.	W91-11193 5E	Toxics Reduction: The Legal Framework. W91-11538 6E
W91-10883 5G	Urban Pesticide Waste Management: Strategies	
Dynamic Simulation of Storm Tanks.	for Education and Collection.	Managing Toxic Substances in Municipal
W91-10928 5D	W91-11194 5E	Wastewater Treatment Plants. W91-11540 5D
Great Lakes Total Phosphorus Model: Post	Pesticide Rinseate Management Plan.	
Audit and Regionalized Sensitivity Analysis. W91-10974 2H	W91-11195 5G	Toxicity Reduction Evaluations (TRE's) As a Tool for Meeting Effluent Standards.
W91-109/4	Past, Present, and Future of Water Use and	W91-11542 6E
Critical Area Program of Maryland: Is it Clean-	Management.	Preliminary Data Summary for the Machinery
ing Up the Chesapeake Bay. W91-11006 6B	W91-11209 4A	Manufacturing and Rebuilding Industry.
W31-11000	Towards Management of Environmental Prob-	W91-11589 5B
Successes and Challenges in Developing and	lems in Egypt.	Nutrient Loading Status of the Conestoga River
Implementing Remedial Action Plans to Restore Degraded Areas of the Great Lakes.	W91-11373 6G	Basin, 1985-1989.
W91-11030 6A	Ground Water Contamination from Agricultural	W91-11599 5G
	Sources: Implications for Voluntary Policy Ad-	WATER POLLUTION CONTROLS
Socio-Economic Considerations in Remedial Action Planning for the Great LakesA Case	herence from Iowa and Virginia Farmer's Atti-	Rural Clean Water Program.
Study for Sustainable Development.	tudes.	W91-11184 5G
W91-11031 6A	W91-11437 5G	WATER POLLUTION EFFECTS
Economic Assessment of the Water Quality Ben-	Hong Kong: Can the Dragon Clean its Nest.	Measurement of the Effect of Organic Pollution
efits of Conservation Tillage on Southwestern Ontario Cropland.	W91-11439 5G	on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers.
W91-11050 3F	Remediation of Floating, Open Water Oil Spills: Comparative Efficacy of Commercially Avail-	W91-10469 5A
Micro-Targeting Cropland Retirement for	able Polypropylene Sorbent Booms.	Features of the Limnological Behavior of Salto
Water Quality Improvement: Measuring the Benefits of Increased Information.	W91-11447 5G	Grande's Reservoir (Argentina-Uruguay). W91-10491 5C
W91-11052 3F	Forest Industry Wastewaters.	New Dead Sea.
Management of Irrigation-Induced Contami-	W91-11467 5D	W91-10504 5C
nants.	Trends In Water Pollution Control In the Finn-	
W91-11063 5G	ish Pulp and Paper Industry.	Effects of Pollution on Heterozygosity in the Barnacle Balanus amphitrite (Cirripedia: Thora-
Design of Economic and Efficient Treatment	W91-11468 5G	cica).
Station for Acidic Streams.	Trends in Pollution Control In the Swedish Pulp	W91-10518 5C
W91-11077 5G	and Paper Industry.	Meiofauna of an Experimental Soft Bottom Eco-
Oil Transport Management and Marine Pollu-	W91-11469 5G	system-Effects of Macrofauna and Cadmium
tion Control: Oil Spill Prevention.	Regulatory Requirements for Pulp and Paper	Exposure.
W91-11081 5G	Mill Effluent Control: Scientific Basis and Con-	W91-10519 5C
Behavior of Double Geonet Drainage Systems.	sequences. W91-11470 5G	Field Survey and Hydraulic Study of 'Aoshio' in
W91-11096 5A	W91-114/0	Tokyo Bay.
Ban on Phosphorus in Detergents: The Effects	Goals, Regulations and Information Needs for	W91-10529 5C
on the Phosphorus Contents of Swiss Sewage	Wastewater Discharge ManagementAn Ameri- can Perspective.	Impact of Nutrient Enrichment and Their Rela-
Sludges and on the Efficiency of Phosphorus Elimination by Sewage Treatment Plants.	W91-11471 5G	tion to the Algal Bloom in the Adriatic Sea. W91-10544
W91-11142 5D	Development of Environmental Control Legis-	
	lation and Effluent Standards for Australasian	Life Cycle Strategies of the Red Tide Causing
Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local	Wood Processing Industries.	Flagellates Chattonella (Raphidophyceae) in the Seto Inland Sea.
Management.	W91-11472 5G	W91-10546 5E
W91-11162 5G	Process Internal Measures to Reduce Pulp Mill	Changes and Stress Signs in Plankton Communi-
Communicating with Farmers: Providing Useful	Pollution Load.	ties as a Result of Man-Induced Perturbations in
and Reliable Sources of Information.	W91-11473 5G	Enclosed Coastal Seas (Mediterranean, Baltic)
W91-11164 5G	Effects of Chlorination Conditions On the AOX	W91-10547 50
Emerging Issues at the Intersection of Agricul-	and Chlorinated Phenol Content of Kraft Bleach	Bloom of Coscinodiscus wailesii and DO Defici
tural and Environmental Policy.	Plant Wastewaters.	of Bottom Water in Seto Inland Sea.
W91-11165 5G	W91-11474 5D	W91-10549 50
Crop Data Management Systems, Inc. Meeting	Future Perspectives for the Anaerobic Treat-	Long Term Ecological Changes in the Gulf o
California's Pesticide Regulation Challenge.	ment of Forest Industry Wastewaters.	Thailand.
W91-11177 5G	W91-11478 5D	W91-10551 5I

Benthic Faunal Succession in a Cove Organically Polluted by Fish Farming. W91-10554 5C	Biochemical and Histochemical Observations on Effects of Low-Level Metal Load (Lead, Cad- mium) in Different Organ Systems of the Fresh-	Trout (Oncorhynchus mykiss) Exposed to Diethyldithiocarbamate and Amylxanthate. W91-10901 5C
	water Crayfish, Astacus astacus L. (Crustacea:	W91-10901 3C
Effects of Oil Pollution on Bio-Ecology and Fisheries on Certain Enclosed Coastal Regions of Arabian Sea.	Decapoda). W91-10827 5B	LC-50 Estimates and Their Confidence Intervals Derived for Tests with Only One Concentration
W91-10555 5B	Effect of 3,4-Dichloroaniline on the Early Life	with Partial Effect. W91-10930 5C
Ecological Modelling at Osaka Bay Related to	Stages of the Zebrafish (Brachydanio rerio): Re- sults of a Comparative Laboratory Study.	Humic Substances in Acid Surface Waters;
Long-Term Eutrophication. W91-10556 5C	W91-10828 5A	Modelling Aluminium Binding, Contribution to Ionic Charge-Balance, and Control of pH.
Simulation of Bioecological and Water Quality	Ultrastructural and Biochemical Effects of Cad-	W91-10933 5C
Processes in Enclosed Coastal Seas. W91-10557 5C	mium on the Aquatic Fern Marsilea minuta Linn.	Factors Affecting the Relationship Between the
Mariculture and Eutrophication in Jinhae Bay,	W91-10829 5C	NBOD Values and the Amounts of Nitrogenous Pollutants: A Field Study on the Lee River.
Korea.	Initial Evaluation of Developmental Malforma- tion as an End Point in Mixture Toxicity Hazard	W91-10940 5C
W91-10558 5B	Assessment for Aquatic Vertebrates.	Acute Phototoxicity of Harbor and Tributary
Studies on the Situation of Pollution and Coun- termeasures of Control of the Oceanic Environ-	W91-10832 5C	Sediments from Lower Lake Michigan. W91-10977 5C
ment in Zhoushan Fishing Ground: The Largest Fishing Ground in China.	Acute Aquatic Toxicity of Alkyl Phenol Ethox- ylates.	Environmental Problems and Solutions: Green-
W91-10559 5C	W91-10833 5C	house Effect, Acid Rain, Pollution.
Incidence and Ecology of Marine Fouling Orga-	Effect of Pesticide Treatments on Nontarget Or-	W91-11066 5B
nisms in the Eastern Harbour of Alexandria, Egypt.	ganisms in California Rice Paddies. W91-10835 5C	Effects of Acid Rain on Epiphytic Orchid Growth.
W91-10560 5C	Dioxin Contamination and Growth and Devel-	W91-11076 5C
Countermeasures Against Water Pollution in	opment in Great Blue Heron Embryos. W91-10837 5C	Preliminary Data Summary for Industrial Laun-
Enclosed Coastal Seas in Japan. W91-10572 5G	Subchronic Hepatotoxicity of Selenomethionine	dries. W91-11093 5B
Formation of Oxygen-Deficient Water Mass in	Ingestion in Mallard Ducks.	Urbanization and Urban Water Problems in
Omura Bay. W91-10592 5B	W91-10838 5C	Southeast Asia: A Case of Unsustainable Devel-
Health Risk Assessment of Water Contaminants	Trace Metal Interactions with Marine Phyto- plankton.	opment. W91-11263 6G
Using Baseline Data of Cancer Incidence in Dif-	W91-10853 2L	Marine Monitoring in Heterogeneous Environ-
ferent Water Supply Areas. W91-10614 5F	Effects of pH and Aluminum on the Growth of the Acidophilic Diatom Asterionella ralfsii var.	ments. W91-11264 5A
Thames Water's Experiences with Cryptospori-	americana.	
dium. W91-10617 5C	W91-10862 2H	Standard Test Fish for India and the Neighbor- ing Countries.
Prospective Epidemiological Study of Drinking	Modification of Benthic Community Structure in Response to Acid-Iron Wastes Discharge.	W91-11300 5A
Water Related Gastrointestinal Illnesses. W91-10618 5B	W91-10869 5C	Enhancement of Hepatocarcinogenesis in Rain- bow Trout with Carbon Tetrachloride.
Atrazine Hazards to Fish, Wildlife, and Inverte-	Impact of Titanium Dioxide Waste on Fertiliza-	W91-11301 5C
brates: A Synoptic Review.	tion in the Sea Urchin Echinometra mathaei. W91-10870 5C	Toxicity of Metals to a Freshwater Tubificid
W91-10709 5C	Immunochemical Detection of Cytochrome	Worm, Tubifex tubifex (Muller). W91-11303 5C
Preliminary Data Summary for the Pharmaceuti- cal Manufacturing Point Source Category.	P450IA1 Induction in Cod Larvae and Juveniles Exposed to a Water Soluble Fraction of North	Assessment of Mercury Toxicity by the Changes
W91-10710 5B	Sea Crude Oil.	in Oxygen Consumption and Ion Levels in the
Preliminary Data Summary for the Paint For-	W91-10871 5A	Freshwater Snail, Pila giobosa, and the Mussel, Lamellidens marginalis.
mulating Point Source Category. W91-10714 5C	Coefficient of Pollution (p): The Southern Cali- fornia Shelf and Some Ocean Outfalls.	W91-11304 5C
Species Composition of Fish Communities in	W91-10874 5B	Effect of Coal-Mine Effluent on Fungal Assem-
Northern Wisconsin Lakes: Relation to pH. W91-10725 5C	Patella vulgata, Mytilus minimus and Hyale pre- vosti as Bioindicators for Pb and Se Enrichment	biages and Leaf Breakdown. W91-11320 5C
Health Risk Assessment of Toluene in California	in Alexandria Coastal Waters.	Gammarus: Asellus Ratio as an Index of Organic
Drinking Water. W91-10741 5C	W91-10875 5A	Pollution. W91-11331 5A
Urban Storm-Induced Discharge Impacts.	Effects of Linear Alkylbenzene Sulphonate (LAS) on Skeletal Development of Sea Urchin	Simplified Phosphorus Trophic State Model for
W91-10745 5B	Embryos (Paracentrotus lividus LMK). W91-10891 5C	Warm-Water Tropical Lakes.
Drinking Water Criteria Document on Xylene. W91-10757 5C	Role of Phosphorus Cycling in Algal Metabo-	W91-11332 3C
	lism and Algal Succession in Lake Donghu,	Results of the First Pilot-Scale Controlled Cohort Epidemiological Investigation into the
Inhibition of NO3(-), NH4(+), and PO4(3-) Uptake in Anabaena doliolum Exposed to a Pe-	China. W91-10897 5C	Possible Health Effects of Bathing in Seawater at Langland Bay, Swansea.
troleum Oil. W91-10825 5C	Effects of Copper and Tributyltin on Stress Pro-	W91-11366 5C
Induction of Biotransformation in the Liver of	tein Abundance in the Rotifer Brachionus plica-	Downstream Changes in Caddisfly Composition
Eel (Anguilla anguilla L.) by Sublethal Exposure	tilis. W91-10900 5C	and Abundance in Relation to Changes in Water Conductivity and Oxygen in the River Butron
to Dinitro-o-cresol: An Ultrastructural and Bio- chemical Study.	Decreased Norepinephrine and Epinephrine	Basin.
W91-10826 5C	Contents in Chromaffin Tissue of Rainbow	W91-11403 3C

# WATER POLLUTION EFFECTS

Assessment of Water Balluties using Distant	WATER POLLUTION MANAGEMENT	Towards Management of Environmental Deah
Assessment of Water Pollution using Diatom		Towards Management of Environmental Prob-
Community Structure and Species Distribution- A Case Study in a Tropical River Basin.	EC Bathing Water Virological Standard: Is It Realistic.	lems in Egypt. W91-11373 6G
W91-11404 5C	W91-10622 5A	W91-11373 6G
W31-11404 3C	W 91-10022	Development of Environmental Control Legis-
Usefulness of Various Numerical Methods for	Production and Control of Reference Materials	lation and Effluent Standards for Australasian
Assessing the Specific Effects of Pollution on	for Water Microbiology.	Wood Processing Industries.
Aquatic Biota.	W91-10623 5A	W91-11472 5G
W91-11406 5C	Manager Production of a Natural Continu	
	Iterative Evaluation of a Lake Water Quality	Biological Bleaching of Wood PulpsA Viable
Variation in the Acidity of Ground and Surface	Management Program. W91-10808 5G	Chlorine-Free Bleaching Technology.
Waters in Northern Ireland.	W 91-10000	W91-11476 5G
W91-11407 2H	WATER POLLUTION PREVENTION	Closing Paper Mill Whitewater Circuits by In-
Effects of Suspended Sediments on Aquatic	Impact of Changing Regional Emissions on Pre-	serting an Anaerobic Stage with Subsequent
Ecosystems.	cipitation Chemistry in the Eastern United	Treatment.
W91-11426 5C	States.	W91-11477 5G
	W91-10473 5G	
Aral Sea Basin: A Critical Environmental Zone.	Properties of Linear Programming Models for	WATER POLLUTION SOURCES
W91-11441 6G	Acid Rain Abatement.	Uncertainty Analysis for a Linear Programming
	W91-10477 5G	Model for Acid Rain Abatement.
Impact of a Pulse Application of Permethrin on		W91-10470 7C
the Macroinvertebrate Community of a Head-	Boston's Sewage Outfall.	
water Stream.	W91-10485 5D	Increased Precipitation Acidity in the Central
W91-11456 5C	A suifer Pastanation, Which Mathed	Sierra Nevada.
Studies on the Effects of Some Organic Pollut-	Aquifer Restoration: Which Method. W91-10486 5G	W91-10471 5B
ants on the Heavy Metal Transport in an Indian	W91-10480	Impact of Changing Regional Emissions on Pre-
Soil.	Water Quality Management Issues in Lingayen	cipitation Chemistry in the Eastern United
W91-11457 5C	Gulf, Philippines and Some Proposed Solutions.	States.
	W91-10523 5G	W91-10473 5G
Effects of Chlornitrofen, a Herbicide, on Repro-		1171-10415
duction of Brachionus urceolaris (Rotatoria)	Assessment of the Environmental Capacity of	Comparison of Nocturnal Drainage Flow in
Through Water and Food (Chlorella).	Enclosed Coastal Sea.	Three Tributaries.
W91-11458 5C	W91-10571 5E	W91-10501 2E
	Environmental Research, Policy and Regula-	
Eutrophication of Pulp and Paper Wastewater	tion: The Chesapeake Bay Experience.	Runoff Characteristics of COD, BOD, C, N, and
Recipients.	W91-10575 5G	P Loadings from Rivers to Enclosed Coastal
W91-11509 5C		Seas.
Saprobiological Investigations on the Bottom	Integrated Management of the Baltic Sea.	W91-10521 5B
Flora of the River Recknitz in the Northern Part	W91-10580 5G	Evaluation of Primary Production Loads and
of the Mecklenburgian Lake District (GDR)	Buffer Strips to Protect Water Supply Reser-	Their Control in Enclosed Seas.
(Saprobiologische Untersuchungen an der	voirs: A Model and Recommendations.	W91-10524 5G
Benthosflora der Recknitz im Norden der Meck-	W91-10816 5G	
lenburger Seenplatte (DDR)).		North Sea Strategies.
W91-11520 2E	Northwest Kansas Groundwater Management	W91-10530 5G
W	District No. 4. An Abandoned Well Program.	
Hydrobiological Survey of the Chanomi Creek	W91-11188 5G	Eutrophication in Hiroshima Bay.
System, Lower Niger Delta, Nigeria.	AgriSource: The Information System for Crop	W91-10536 5B
W91-11524 5C	Technology.	Benthic Faunal Succession in a Cove Organical-
Rise and Fall of the Potomac River Striped Bass	W91-11196 10D	ly Polluted by Fish Farming.
Stock: A Hypothesis of the Role of Sewage.		W91-10554 5C
W91-11529 5C	Developing a Groundwater Training Program	
	for Pesticide Users.	Effects of Oil Pollution on Bio-Ecology and
Chemical and Biological Factors Affecting Acid	W91-11199 5G	Fisheries on Certain Enclosed Coastal Regions
Tolerance of Smallmouth Bass.	Manufand's Taxin The Taxings Basesam Hause	of Arabian Sea.
W91-11530 5C	Maryland's Train-The-Trainer Program House- hold Hazardous Waste.	W91-10555 5E
Sensitivity of Greenheat Cutthenat Tout	W91-11200 5G	Marianituse and Entereties in the San
Sensitivity of Greenback Cutthroat Trout to Acidic pH and Elevated Aluminum.		Mariculture and Eutrophication in Jinhae Bay, Korea.
W91-11531 5C	Farm Bureau's Groundwater and Environmental	W91-10558 5E
30	Quality Self-Help Checklist for Farmsteads and	W 71-10030
Quality of Salmonid Hatchery Effluents During	Farm Fields.	Studies on the Situation of Pollution and Coun-
a Summer Low-Flow Season.	W91-11201 5G	termeasures of Control of the Oceanic Environ-
W91-11532 5D	Florida's Passicida Water Ovellan Data Co	ment in Zhoushan Fishing Ground: The Larges
	Florida's Pesticide Water Quality Education	Fishing Ground in China.
Sediment Denitrification Potential in the Eliza-	Program. W91-11202 5G	W91-10559 5C
beth River, Virginia.	W91-11202 5G	
W91-11537 5C	Strategies for Nonprofit Organizations for Pre-	Man-Made Garbage Pollution on the Mediterra
Havard Assessment Bassasch Strateres for	venting Agrichemical Contamination of Ground	nean Coastline.
Hazard Assessment Research Strategy for Ocean Disposal.	Water.	W91-10569 5E
W91-11551 5E	W91-11204 5G	Environmental Assessment of Wastewater
3E	In the Land of the City Comment Co.	Marine Disposal of Xiaogang Zone, Ningbo
Mechanisms of Resistance to Polychlorinated	In the Land of the Giants: Grassroots Organiz-	W91-10570 SE
Biphenyls (PCB) in Two Species of Marine Dia-	ing in California's Central Valley. W91-11205 5G	
toms.	W71-11203	Countermeasures Against Water Pollution is
W91-11562 5C	Hydraulicking in Environmental Protection and	Enclosed Coastal Seas in Japan.
	Restoration.	W91-10572 5C
Assessing the Response of Emerald Lake, an	W91-11283 5G	
Alpine Watershed in Sequoia National Park,	A 11 A1	Controlling Effect of the Planned Managemen
California, to Acidification during Snowmelt by	Soil Clean Up by In-situ Aeration: VI. Effects of	of the Environment in the Kagoshima Bay or
Using a Simple Hydrochemical Model.	Variable Permeabilities.	the Pollutant Load.
W91-11594 5C	W91-11317 5G	W91-10579 50

Integrated Management of the Baltic Sea. W91-10580 5G	Preliminary Data Summary for the Pesticide Chemicals Point Source Category.	Road Salting Impacts in Massachusetts. W91-11053 4C
	W91-10739 5B	Harman Mark Tarana and Ale Great Labor by
Sewage Treatment and Disposal Strategies in Greece.	Superfund Record of Decision: Reich Farms, NJ.	Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial
W91-10598 5G	W91-10743 5G	Evaluation. W91-11062 5B
Coal Mine Waters and Their Influence on the Purity Ecological State of River and the Fish Production.	Urban Storm-Induced Discharge Impacts. W91-10745 5B	Environmental Problems and Solutions: Green- house Effect, Acid Rain, Pollution.
W91-10605 5B	Soil Vapor Survey at the LLNL Site 300 Gener-	W91-11066 5B
Waterborne Disease Outbreak. W91-10615 5C	al Services Area, Adjacent Portions of the Con- nolly and Gallo Ranches and the Site 300 Land- fill Pit 6 Area.	Acid Precipitation: A Review. W91-11074 5B
Causes of Waterborne Outbreaks in the United	W91-10747 5B	Relationship of Regional Water Quality to Aqui- fer Thermal Energy Storage.
States. W91-10616 5B	Superfund Record of Decision. Mid-State Dis- posal Landfill, WI.	W91-11082 5C
Thames Water's Experiences with Cryptospori-	W91-10749 5G	Comparative Physico-Chemical Analysis of
dium. W91-10617 5C	Confirmatory Chemical Analyses and Solid Phase Bioassays on Sediment from the Columbia	Drinking, Ground and Industrial Waste Water of Jodhpur. W91-11083 5B
Public Health Criteria for the Aquatic Environ- ment: Recent WHO Guidelines and Their Appli-	River Estuary at Tongue Point, Oregon. W91-10753 5B	Estimation of Trace Metals Levels in Power and
cation. W91-10620 5G	Superfund Record of Decision: Kin-Buc Land- fill, NJ.	Industrial Waste Water of Jodhpur by Differen- tial Pulse Anodic Stripping Voltammetry.
Staphylococci in Polluted Waters and in Waters	W91-10755 5G	W91-11084 5A
of Uninhabited Areas. W91-10631 5B	Superfund Record of Decision: Palmerton Zinc Pile, PA.	Assessment of Hydrogeologic Conditions with Emphasis on Water Quality and Wastewater In-
Studies on the Bacterial Fauna of the Tamagawa	W91-10756 5G	jection, Southwest Sarasota and West Charlotte Counties, Florida.
River. W91-10632 5B	Superfund Record of Decision: South Valley/ Edmunds Street, NM.	W91-11087 2F
Bacterial Water Quality in Urban Receiving	W91-10758 5G	Geophysical and Chemical Investigations of Ground Water at Five Industrial or Waste-Dis-
Waters. W91-10633 5B	Effects of Land-Use Buffer Size on Spearman's Partial Correlations of Land Use and Shallow	posal Sites in Logan Township, Gloucester County, New Jersey, 1983-87.
Study of Campylobacter in Sewage, Sewage	Ground-Water Quality. W91-10761 4C	W91-11092 5B
Sludge and in River Water. W91-10634 5D	Fluxes and Transport of Anthropogenic and Natural Polycyclic Aromatic Hydrocarbons in	Preliminary Data Summary for Industrial Laundries.
Enumeration of Motile Aeromonas in Valencia Coastal Waters by Membrane Filtration.	the Western Mediterranean Sea.  W91-10841  5B	W91-11093 5B  Executive Summary-Assessing the Response of Emerald Lake, An Alpine Watershed in Sequoia
W91-10636 5B Review of the Epidemiology and Diagnosis of	Effect of Three Primary Treatment Sewage Outfalls on Metal Concentrations in the Fish	National Park, California, to Acidification During Snowmelt Using a Simple Hydrochemi-
Waterborne Viral Infections. W91-10651 5B	Cheilodactylus fuscus Collected Along the Coast of Sydney, Australia. W91-10873 5B	cal Model. W91-11112 7C
Virological Investigation of the River Elbe. W91-10652 5B	Delay in Lake Recovery Caused by Internal Loading.	Organic Substances in Soils and Plants after Intensive Applications of Sewage Sludge.
Virological Quality of Recreational Waters in	W91-10886 2H	W91-11126 5E
the Netherlands. W91-10653 5B	Volatile Organic Compounds in Two Polluted Rivers in Barcelona (Catalonia, Spain).	Stream Chemistry in the Eastern United States:  1. Synoptic Survey Design, Acid-Base Status,
Superfund Record of Decision: Chemtronics	W91-10887 5B	and Regional Patterns. W91-11241 5B
(Amendment), NC. W91-10713 5G	Distribution of Dissolved Cadmium, Lead and Copper in the Bristol Channel and the Outer	Stream Chemistry in the Eastern United States: 2. Current Sources of Acidity in Acidic and
Superfund Record of Decision: IBM (San Jose), CA.	Severn Estuary. W91-10925 5B	Low Acid-Neutralizing Capacity Streams. W91-11242 5B
W91-10715 5G	Non-Point Source Loadings of Nutrients and	Air Quality and Deposition of Trace Elements in
Superfund Record of Decision: Delaware Sand and Gravel, DE.	Dissolved Organic Carbon from an Agricultural- Suburban Watershed in East Central Florida. W91-10927 5B	the Province of South-Holland. W91-11248 5E
W91-10717 5G	Prospecting for Zones of Contaminated Ground-	Major Ions in Marine Rainwater With Attention
Superfund Record of Decision: Iron Horse Park, MA.	Water Discharge to Streams Using Bottom-Sedi- ment Gas Bubbles.	to Sources of Alkaline and Acidic Species. W91-11250 5E
W91-10719 5G	W91-10951 5B	Distribution and Migration of Heavy Metals in
Superfund Record of Decision: South Valley (PL-83), NM.	Polychlorinated Biphenyls in Dated Sediment Cores from Green Bay and Lake Michigan.	the Environment of the Altai Mountains in Con- nection with Ecological Substantiation of the
W91-10721 5G	W91-10979 5B	Katun Hydroelectric Station Project. W91-11292 5E
Remedial Investigation of the High Explosives Burn Pit Facility, Building 829 Complex, Law-	Phosphorus from Internal Sources in the Lau- rentian Great Lakes, and the Concept of Thresh-	NOAA Satellite Data in Natural Oil Slick De
rence Livermore National Laboratory Site 300. W91-10731 5B	old External Load. W91-10982 5B	tection, Otway Basin, Southern Australia. W91-11296 5A
Preliminary Data Summary for the Hospitals	Political Economic Model of International Pol-	Contamination of Ponds by Fenitrothion during
Point Source Category. W91-10738 5B	lution. W91-11016 5B	Forest Spraying. W91-11298 5E

## WATER POLLUTION SOURCES

Transport of the Fungicide Chlorothalonil from	Assessment of Agricultural Nutrient Point	WATER PROPERTIES
Its Operational Use on a Pond Ecosystem. W91-11299 5B	Source Discharge from Tile Drains, Spring and Overland Runoff from Two Farms, Dauphin	Optics of Little Sodus Bay. W91-10980 2H
Laboratory Studies of Virus Survival During	County, Pennsylvania. W91-11600 5B	Impact of Physico-chemical Complexes on
Aerobic and Anaerobic Digestion of Sewage Sludge.	WATER POLLUTION TREATMENT	Plankton Density in Dhir Beel of Assam.
W91-11319 5D	Long Climb to Remediation.	W91-11527 2H
Distribution of Fecal Pollution Indicator Bacte-	W91-10483 5G	Seasonal Variations and Relationships of Differ- ent Physico-chemical Characteristics in Newly
ria in Lake Kinneret. W91-11322 5B	Aquifer Restoration: Which Method. W91-10486 5G	Made Tawa Reservoir.
		W91-11528 2H
Methyl and Butyltin Compounds in Water and Sediments of the Rhine River.	Use of Respiration in the Sandy Beach or on the Tidal Flat: 1. Permeable Sandy Beach.	WATER QUALITY
W91-11335 5B	W91-10541 5G	Ground Water: How Contaminated. W91-10484 5G
Phenyltins in Water, Sediment, and Biota of	Measures for Purification of the Leachate from	
Freshwater Marinas. W91-11342 5B	'Renseanlaeg Damhusaen' into Copenhagen Waters, to Meet the NPO-Plan.	Pollution and Protection of Bohai Bay. W91-10522 5B
	W91-10601 5D	Numerical Circulation of Water Orollin in
Sheep-Dips as a Source of Pollution of Fresh-	11-1 Oli S-11 Di	Numerical Simulation of Water Quality in Tokyo Bay.
waters: A Study in Grampian Region. W91-11356 5B	Using Oil Spill Dispersants on the Sea. W91-10716 5G	W91-10528 5B
Trace Element Distribution in Surficial Sedi-	Fiscal Year 1988 Supported Liquid Membrane	Simulation of Bioecological and Water Quality
ments of the Northern Tyrrhenian Sea: Contri-	Development Report.	Processes in Enclosed Coastal Seas.
bution to Heavy-Metal Pollution Assessment. W91-11444 5A	W91-10727 5G	W91-10557 5C
W31-11444	Biotechnology Degradation and Mitigation of	Clostridium perfringens, as an Indicator Micro-
Heavy Metal Distribution in the Godvari River	Offshore Oil Spills, Phase 1. Main Report: Tech- nology to Enhance Biodegradation of Oil Spills	organism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems.
Basin. W91-11445 5B	State of the Art and Perspectives for Technolo-	W91-10686 5D
	gy Development.	
Deforestation and Leaching of Nitrogen as Ni- trates into Underground Water in Intertropical	W91-10735 5G	Lake Lansing Dredging Evaluation Study, 1978- 1984.
Zones: The Example of Cote d'Ivoire.	Mechanistic Evaluation of Mitigation of Petrole-	W91-10748 5G
W91-11446 2F	um Hydrocarbon Contamination by Soil Medium.	Ambient Woter Quality Criteria for Ammonia
Radioactivity in Water Treatment Wastes: A	W91-10779 5G	Ambient Water Quality Criteria for Ammonia (Saltwater)-1989.
USEPA Perspective.		W91-10750 5G
W91-11461 5B	Computer Modeling of Scale Formation During Treatment of Ground Water in Air Strippers.	Land Use, Water Use, Streamflow Characteris-
Identification of Dioxin Sources In an Integrated	W91-10798 5G	tics, and Water-Quality Characteristics of the
Wood Processing Facility. W91-11475 5B	Comparison Between Model Simulations and	Charlotte Harbor Inflow Area, Florida. W91-10771 4C
	Field Results for In-Situ Biorestoration of Chlor-	
Formation of Chlorophenols and Related Com- pounds In Natural and Technical Chlorination	inated Aliphatics: Part 1. Biostimulation of Methanotrophic Bacteria.	Water Management Issues for the Nineties. W91-10807 6D
Processes.	W91-10955 5G	
W91-11508 5B	Design of Economic and Efficient Treatment	Political Economic Model of International Pol-
Eutrophication of Pulp and Paper Wastewater	Station for Acidic Streams.	lution. W91-11016 5B
Recipients. W91-11509 5C	W91-11077 5G	
	Analytical Modeling of Aquifer Decontamina-	Economic Assessment of the Water Quality Ben- efits of Conservation Tillage on Southwestern
Quality of Salmonid Hatchery Effluents During a Summer Low-Flow Season.	tion by Pumping When Transport is Affected by	Ontario Cropland.
W91-11532 5D	Rate-Limited Sorption. W91-11235 5G	W91-11050 3F
		Willingness-to-Pay for Protection of Water Sup-
New Storm Water Regulations Require Signifi- cant Compliance Actions by Both Industries and	Optimal Data Acquisition Strategy for the De- velopment of a Transport Model for Ground-	plies in Four Massachusetts' Towns.
Municipalities.	water Remediation.	W91-11056 6C
W91-11541 5D	W91-11238 5G	Evaluating the Impact of Water Quality Upon
Sources and Extent of Groundwater Contamina-	Use of Ligand-Modified Micellar-Enhanced Ul-	the Value of Recreational Fishing. W91-11058 6G
tion. W91-11546 5B	trafiltration in the Selective Removal of Metal Ions from Water.	
	W91-11318 5D	Studies on Assessment of Water Balance and Its Quality in Gurpur River Basin, Karnataka State,
Description of the Physical Environment and Coal-Mining History of West-Central Indiana,	Electrolytic Model System for Reductive Deha-	India.
with Emphasis on Six Small Watersheds.	logenation in Aqueous Environments.	W91-11065 5B
W91-11576 2E	W91-11343 5B	Geohydrology and Water Quality of Kalamazoo
Superfund Record of Decision: Intel (Mountain	Application of Supported Liquid Membranes for	County, Michigan, 1986-88.
View), CA.	Removal of Uranium From Groundwater.	W91-11091 2F
W91-11581 5G	W91-11370 5G	Methodology to Derive Water-Quality Trends
Status Report on Remedial Investigation of the	Migration and Treatment of a Dense Aqueous	for Use by the National Water Summary Pro- gram of the U.S. Geological Survey.
300 Area Process Ponds. W91-11583 5G	Contaminant Source and Plume. W91-11380 5G	W91-11110 7E
Preliminary Data Summary for the Machinery Manufacturing and Rebuilding Industry.	Assessment of International Technologies for Superfund Applications.	National Pesticide Usage Data Base. W91-11176 7C
W91-11589 5B	W91-11584 5G	
Nutrient Loading Status of the Conestoga River	WATER PRESSURE	Nature of Suspended Solids and IRS1A-LISSI Data: A Case Study of Tawa Reservoir (Nar-
Basin, 1985-1989.	Drag on Vertical Sill of Forced Jump.	mada Basin).
W91-11599 5G	W91-10985 8B	W91-11221 5G

Effect of Hydroelectric Stations on Water Quality and Development of Phytoplankton in the Lower Pools of Reservoirs.	Agrichemicals and Groundwater Protection: Resources and Strategies for State and Local Management.	Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10669 5A
W91-11289 6G Saprobiological Investigations on the Bottom	W91-11162 5G	PCR and Environmental Monitoring: The Way
Flora of the River Recknitz in the Northern Part of the Mecklenburgian Lake District (GDR)	Continuous Flow Thin-Layer Headspace (TLHS) Analysis. I. Conductometric Determi-	Forward. W91-10670 5A
(Saprobiologische Untersuchungen an der Benthosflora der Recknitz im Norden der Meck-	nation of Volatile Organic Halogens (VOX) in Tap Water. W91-11256 5A	Disinfection Capability in Water for Swimming and Bathing Pools: A Simple Method for Their
lenburger Seenplatte (DDR)). W91-11520 2E	Danube River Basin: Negotiating Settlements to	Evaluation in Practice. W91-10684 5F
Trends in Water-Quality Data in Texas. W91-11593 5B	Transboundary Environmental Issues. W91-11387 5G	Comparative Physico-Chemical Analysis of Drinking, Ground and Industrial Waste Water
WATER QUALITY CONTROL	WATER QUALITY MONITORING Environmental Information Processing of	of Jodhpur. W91-11083 5B
Mathematical Modelling for Reservoir Water- Quality Management Through Hydraulic Struc-	Closed Bay Area by Remote Sensing. W91-10581 7B	New Standards for the Determination of Geos-
tures: A Case Study. W91-10490 5G	Personal Computer System Supporting Water	min and Methylisoborneol in Water by Gas Chromatography/Mass Spectroscopy.
FACTA 1990 Conservation and Environmental Highlights.	Quality Management in Eutrophicated Bay. W91-10582 5G	W91-11329 5A  Gammarus: Asellus Ratio as an Index of Organic
W91-10507 5G	Health-Related Water Microbiology 1990.	Pollution.
Assessment of the Environmental Capacity of Enclosed Coastal Sea.	W91-10612 5F	W91-11331 5A  In-Situ Sediment Oxygen Demand in Five
W91-10571 5E	Microbiological Methods for Safety Testing of Drinking Water Directly Reclaimed from	Southwestern U.S. Lakes. W91-11333 2H
Environmental Management of the Puget Sound.	Wastewater. W91-10613 5A	Coliphage and Bacteriophage as Indicators of
W91-10577 5G	Waterborne Disease Outbreak.	Recreational Water Quality. W91-11334 5A
Sea and Fresh Water Conservation. W91-10578 5G	W91-10615 5C	Relationship of MSS and TM Digital Data with
Bacteriophages as Model Viruses in Water Qual-	EC Bathing Water Virological Standard: Is It Realistic.	Suspended Sediments, Chlorophyll, and Tem- perature in Moon Lake, Mississippi.
ity Control. W91-10883 5G	W91-10622 5A	W91-11354 7C
Removal of Biota from Inter-Basin Transfer Water.	Production and Control of Reference Materials for Water Microbiology. W91-10623 5A	WATER QUALITY STANDARDS Water Quality Management Issues in Lingayen
W91-11017 5F	W91-10623 5A Surveillance Solutions to Microbiological Prob-	Gulf, Philippines and Some Proposed Solutions. W91-10523 5G
Analysis of Ground-Water Flow in the A-Sand Aquifer at Paramaribo, Suriname, South Amer- ica.	lems in Water Quality Control in Developing Countries.	Sea and Fresh Water Conservation. W91-10578 5G
W91-11090 2F	W91-10625 5G	Prospective Epidemiological Study of Drinking
Coordinating Roles and Services: Soil Conserva- tion Service and Extension Service.	Evaluation of Fecal Enterococci Isolation Media to Indicate Fecal Pollution in Chlorinated Water.	Water Related Gastrointestinal Illnesses. W91-10618 5B
W91-11171 6E Wellhead ProtectionInformation and Re-	W91-10626 5F	Use of Risk Assessment for Development of Microbial Standards.
sources. W91-11172 5G	Bacteriological Suitability of Water from Basrah Wells for Drinking.	W91-10619 5G
Minnesota Clean Water Partnership Program.	W91-10629 5A	Public Health Criteria for the Aquatic Environ- ment: Recent WHO Guidelines and Their Appli-
W91-11181 5G	Relationship Between Pseudomonas aeruginosa and Bacterial Indicators in Polluted Natural	cation. W91-10620 5G
Wellhead Protection in Massachusetts: Protect- ing Public Water Supplies from Pesticide Im-	Waters. W91-10635 5A	Need for New Microbiological Water Quality
pacts. W91-11182 5G	Miniaturized Fluorogenic Assays for Enumera-	Criteria. W91-10621 5F
Innovative Subsurface Sewage Management: A	tion of E. coli and Enterococci in Marine Water. W91-10639 5A	EC Bathing Water Virological Standard: Is It
Program to Protect Idaho's Rathdrum Prairie Aquifer.	Difficulty of Using Coliphages as 'Indicators'	Realistic. W91-10622 5A
W91-11186 5G	and 'Index' Organisms. W91-10661 5A	Bacterial Water Quality in Urban Receiving Waters.
Home Water Treatment: Remediating Aldicarb Contamination in Suffolk County, New York.	Occurrence of Male-Specific and Somatic Bac-	W91-10633 5B
W91-11189 5F	teriophages in Polluted South African Waters. W91-10662 5B	Virological Quality of Recreational Waters in the Netherlands.
Water and Human Health. W91-11211 5F	Detection of Poliovirus in Water by Direct Iso-	W91-10653 5B
Bubbleless Aeration. W91-11222 5G	lation of the RNA and Hybridization with Gene Probes.	Groundwater Management Model for Salt Lake County, Utah with Some Water Rights and
Regional Approach to Salinity Management in	W91-10666 5A	Water Quality Considerations. W91-10911 4B
River Basins. A Case Study in Southern Iran. W91-11432 5G	Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water.	Wisconsin's Risk Assessment Based Numerical
WATER QUALITY MANAGEMENT	W91-10667 5A	Groundwater Standards Program. W91-11183 5G
Buffer Strips to Protect Water Supply Reservoirs: A Model and Recommendations.	Detection of Rotaviruses in Water by Gene Probes.	Results of the First Pilot-Scale Controlled
W91-10816 5G	W91-10668 5A	Cohort Epidemiological Investigation into the

## WATER QUALITY STANDARDS

Possible Health Effects of Bathing in Seawater	Dynamics of Water Policy.	Great Lakes Charter: Potential and Reality.
at Langland Bay, Swansea. W91-11366 5C	W91-11212 6E	W91-11004 6E
Development of Environmental Control Legis-	Development of Small Hydro for Remote Areas of Northern Pakistan.	What Makes Regional Organizations Succeed or Fail.
lation and Effluent Standards for Australasian Wood Processing Industries.	W91-11215 8C	W91-11005 6A
W91-11472 5G	Crossing the Next Meridian: Sustaining the	Critical Area Program of Maryland: Is it Clean-
Toxics Reduction: The Legal Framework.	Lands, Waters, and Human Spirit in the West. W91-11440 6E	ing Up the Chesapeake Bay.
W91-11538 6E	Strategic Issues in Watershed Development.	W91-11006 6B
Managing Toxic Substances in Municipal	W91-11564 4D	Changing Dynamics of Interest Representation in Water Resources Management.
Wastewater Treatment Plants. W91-11540 5D	Hydrogeology, Water Quality, and Ground- Water Development Alternatives in the Lower	W91-11007 6E
Toxicity Reduction Evaluations (TRE's) As a	Wood River Ground-Water Reservoir, Rhode Island.	Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes
Tool for Meeting Effluent Standards. W91-11542 6E	W91-11572 2F	and Failures.
WATER QUALITY TRENDS	Photographs Written Historical and Descriptive	W91-11008 6E
Trends in Water-Quality Data in Texas.	Data.	Challenge of Implementing Ecosystem Manage-
W91-11593 5B	W91-11577 6E	ment Plans in the Great Lakes Basin.
WATER RATES	WATER RESOURCES INSTITUTES	W91-11011 6B
Water Rate Structure for Demand Management in the Regional Municipality of Waterloo.	Water Management Issues for the Nineties. W91-10807 6D	Regional Approach to Drought Planning and Management in the Great Lakes Basin.
W91-11049 6C	U.S. Geological Survey Federal-State Coopera-	W91-11012 6A
WATER REQUIREMENTS	tive Water-Resources Program Fiscal Year 1989.	Resolving Conflicts on the Danube: The Gabci-
Water Management Issues for the Nineties.	W91-11109 7B	kovo-Nagymaros Power Dam Project.
W91-10807 6D	WATER RESOURCES MANAGEMENT	W91-11018 6B
WATER RESOURCE INSTITUTES	Do We Have a National Water Policy. W91-10505 6B	1987-89 Drop in Great Lakes Water Levels,
Soil Conservation Service and Extension: Coop- erating to Enhance Services (MES Portion).	Water Futures.	Causes and Effect.
W91-11170 6E	W91-10506 6B	W91-11023 2H
WATER RESOURCE INSTITUTIONS	North Sea Strategies.	Breaking the Incrementalist Trap: Achieving
Minnesota District, Water Resources Division:	W91-10530 5G	Unified Management of the Great Lakes Ecosys- tem.
Information and Technical Assistance. W91-11167 2F	5-Year Scientific Research Programme for Man-	W91-11025 6A
	aging Coastal Seas.	
WATER RESOURCES  Past, Present, and Future of Water Resources	W91-10531 2L	Fluctuating Water Levels in the Great Lakes-St. Lawrence River Basin: An Evaluation Frame-
Management In the United States.	Summary of Ports and Marine Environment Im-	work for the Analysis of Potential Actions.
W91-11207 4A	provement Work and Example of Latest Meas- ures in Seto Inland Sea.	W91-11026 6B
Future Directions for Water Resources.	W91-10545 5G	Great Lakes Water Levels Management: Relax-
W91-11208 4A	Modern Environmental Assessment Procedures	ing the 'Policy Trap'. W91-11027 6A
WATER RESOURCES DATA	for Enclosed Seas.	W91-11027 6A
Statistical Summaries of Selected Iowa Stream- flow Data Through September 30, 1988.	W91-10564 6G	Regulation of Lake Ontario Levels.
W91-10770 2E	Ecological Assessment of Semi-Enclosed Marine	W91-11028 6A
WATER RESOURCES DEVELOPMENT	Water Bodies of the Archipelago Sabana-Cama- guey (Cuba) Prior to Tourism Development	Successes and Challenges in Developing and
Do We Have a National Water Policy.	Projects.	Implementing Remedial Action Plans to Restore Degraded Areas of the Great Lakes.
W91-10505 6B	W91-10566 6G	W91-11030 6A
Water Futures.	Non-Regulatory Approaches to Management of	Socio-Economic Considerations in Remedial
W91-10506 6B	Coastal Resources and Development in San Francisco Bay.	Action Planning for the Great Lakes-A Case
Land Use, Water Use, Streamflow Characteris-	W91-10576 2L	Study for Sustainable Development.
tics, and Water-Quality Characteristics of the Charlotte Harbor Inflow Area, Florida.	Environmental Management of the Puget	W91-11031 6A
W91-10771 4C	Sound.	Fluctuating Great Lakes Water Levels: Progress
Municipal Ground Water from Ancient Crystal-	W91-10577 5G	and Opportunities. W91-11032 6A
line Bedrock.	Environmental Activism in the San Francisco	
W91-10822 2F	Bay Estuary. W91-10585 5G	Fluctuating Water Levels: An Issue Manage- ment Approach.
Removal of Biota from Inter-Basin Transfer		W91-11033 6B
Water. W91-11017 5F	Water Control Systems and the Traditional Fes- tival at Miyawaki, on the Seto Inland Sea.	Limits of Government Responsibility.
	W91-10591 3F	W91-11034 6E
Applying Sustainable Development to the Great Lakes-Experience and Opportunities Under the	Report of the River Master of the Delaware	
Boundary Waters Treaty.	River, for the Period December 1, 1988-Novem-	What Stakeholders Want and Why. W91-11035 6A
W91-11019 6E	ber 30, 1989. W91-10765 4A	
Great Lakes Levels and Flows Under Natural		Institutional Morass: Constraints and Opportuni- ties for Issue Management.
and Current Conditions. W91-11022 2H	Water Management Issues for the Nineties. W91-10807 6D	W91-11036 6A
Milk River: Historical Transitions in an Interna-		So What. Findings and Recommendations from
tional Waterway.	sources Issues.	the Lake Levels Study.
W91-11039 6E	W91-11003 6E	W91-11037 6A

Watershed Years at Niagara Falls: Canadian and	Tensions Between Water Legislation and Cus-	Photographs Written Historical and Descriptive
American Policy Responses to New Meanings of Power, 1905-1914.	tomary Rights. W91-11383 6E	Data. W91-11577 6E
W91-11038 6E	Regulation of Interbasin Transfers and Con-	WATER SAMPLING
Milk River: Historical Transitions in an Interna- tional Waterway.	sumptive Uses from the Great Lakes. W91-11384 6E	Phosphorus in the Truckee River Between Vista and Patrick, Storey and Washoe Counties,
W91-11039 6E	Managing Water Resources in Latin America.	Nevada, August 1984. W91-10763 5A
Interprovincial Water Management in Western Canada.	W91-11385 6B	
W91-11040 6E	Resale of the Columbia River Treaty Down- stream Power Benefits: One Road from Here to	Method for Installing Miniature Multilevel Sam- pling Wells.
Will Free Trade Drink Canada Dry.	There.	W91-10962 5A
W91-11041 6D	W91-11386 6E	WATER SHORTAGE
Comparative Water Management: A Tale of	Danube River Basin: Negotiating Settlements to	Residential Water Conservation: Casa Del Agua.
Two Compacts. W91-11042 6A	Transboundary Environmental Issues.	W91-10814 3D
	W91-11387 5G	WATER STORAGE
Comprehensive Water Management Strategy: Credit River Watershed.	Agency Autonomy in Transboundary Resource	Off-River Storages as Sources and Sinks for Environmental Contaminants.
W91-11043 6A	Management: The United States Section of the International Boundary and Water Commission,	W91-10851 5B
Watershed-Based Conservation Programs is the	United States and Mexico.	WATER STRESS
Public Getting Its Money's Worth.	W91-11388 6E	Tree-Ring Reconstructed Sunshine Duration
W91-11044 6C	Crossing the Next Meridian: Sustaining the	over Central USA. W91-10972 2I
Managing Transboundary Water Diversions:	Lands, Waters, and Human Spirit in the West.	
Experience From a Private Utility. W91-11045 6A	W91-11440 6E	WATER SUPPLY
W91-11045 6A	Watershed Development in Asia: Strategies and	Special Report: Water Supply and Sanitation. W91-10482 5F
New York City's Delaware River Basin	Technologies. W91-11563 6B	W91-10462 3F
Supply-A Case Study in Interstate Coopera- tion	W91-11363	Lessons Learned from a Third World Water and
W91-11046 6E	Soil and Moisture Conservation Technologies:	Sanitation Project. W91-10503 5F
Industrial Water Pricing for Ontario: Towards	Review of Literature. W91-11565 4D	
Realistic Pricing.		Health-Related Water Microbiology 1990. W91-10612 5F
W91-11048 6C	Framework for Planning, Monitoring, and Eval- uating Watershed Conservation Projects.	W 51-10012
Water Rate Structure for Demand Management in the Regional Municipality of Waterloo.	W91-11570 6B	Report of the River Master of the Delaware River, for the Period December 1, 1988-Novem-
W91-11049 6C	Evolution of Nevada's Water Laws, as Related	ber 30, 1989. W91-10765 4A
Water Diversion from the Great Lakes as a	to the Development and Evaluation of the State's Water Resources, from 1866 to about	W71-10/03
Dynamic Game.	1960.	Water Management Issues for the Nineties.
W91-11051 6B	W91-11573 6E	W91-10807 6D
Water Market in the Southern Front Range of	Review of Fisheries Habitat Improvement	Buffer Strips to Protect Water Supply Reser-
Colorado.	Projects in Warmwater Streams, with Recom-	voirs: A Model and Recommendations. W91-10816 5G
W91-11055 6D	mendations for Wisconsin. W91-11591 2H	
Minnesota Clean Water Partnership Program.		Pulsed Field Electrophoresis of Genomic Re-
W91-11181 5G	WATER REUSE	striction Fragments for the Detection of Noso- comial Legionella pneumophila in Hospital
Minnesota's Olmsted County: A Cooperative	Microbiological Methods for Safety Testing of Drinking Water Directly Reclaimed from	Water Supplies.
Health Based Perspective on Zoning and Plan-	Wastewater.	W91-10836 5A
ning. W91-11187 6B	W91-10613 5A	Legal Regimes for Interstate Water Allocation
	Residential Water Conservation: Casa Del Agua.	in the Western United States: Some Successes
Water Management in the 21st Century. W91-11206 4A	W91-10814 3D	and Failures. W91-11008 6E
	Design and Performance of the BIOFISH Water	
Past, Present, and Future of Water Resources Management In the United States.	Recirculation System.	Comparison of Mean Annual Runoff Estimates in the Canadian Portion of the Great Lakes
W91-11207 4A	W91-11548 5D	Basin.
Future Directions for Water Resources.	WATER RIGHTS	W91-11020 2E
W91-11208 4A	Negotiation Techniques to Resolve Western Water Disputes.	Will Free Trade Drink Canada Dry.
Past, Present, and Future of Water Use and	W91-10817 6E	W91-11041 6D
Management.	Transferability of Water Entitlements in Austra-	New York City's Delaware River Basin
W91-11209 4A	lia.	Supply-A Case Study in Interstate Coopera
Future Water Management Problems: The Fed-	W91-10850 6E	tion
eral Role In Their Solution.	Groundwater Management Model for Salt Lake	W91-11046 6E
W91-11210 4A	County, Utah with Some Water Rights and	Costs and Benefits of Moving to Peak-Load
Dynamics of Water Policy.	Water Quality Considerations. W91-10911 4B	Pricing for Municipally-Supplied Water. W91-11047
W91-11212 6E		
Legislative Implementation of Integrated Catch-	Water Market in the Southern Front Range of	Industrial Water Pricing for Ontario: Toward Realistic Pricing.
ment Management in Western Australia. W91-11374 6E	Colorado. W91-11055 6D	W91-11048 60
Groundwater Depletion in India: Institutional Management Regimes.	Tensions Between Water Legislation and Cus- tomary Rights.	Water Rate Structure for Demand Managemen in the Regional Municipality of Waterloo.
W91-11382 4B	W91-11383 6E	

## WATER SUPPLY

Water Supply Implication of Climate Change in Western North American Basins.	Evaluation of Fecal Enterococci Isolation Media to Indicate Fecal Pollution in Chlorinated	Efficiency of an Ozoflotation-Filtration Process for the Treatment of the River Thames at
W91-11059 2B	Water. W91-10626 5F	Walton Works. W91-11268 5F
Wellhead Protection in Massachusetts: Protect-		W91-11208 5F
ing Public Water Supplies from Pesticide Impacts. W91-11182 5G	Coliform Bacteria in Drinking Water from South Bavaria: Identification by the API 20E-System and Resistance Patterns.	Criteria for Flocculator Design. W91-11269 5F
Past, Present, and Future of Water Resources	W91-10627 5F	Use of a Backflush Technique in Cross-flow
Management In the United States. W91-11207 4A	Effect of Heat Shock on Recovery of Escheri- chia coli from Drinking Water.	Microfiltration for Treating Natural Water and Filter Backwash Wastewater in Water Works.
Method of Compiling Water-Management Bal-	W91-10628 5F	W91-11270 5F
ances. W91-11293 2A	Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Poten-	Cryptosporidiosis and Water Supply: A Brief Review, with Special Reference to the Report of
Channel Tunnel and Its Impact on the Folkes-	tial Regrowth of Bacteria.	the Badenoch Committee. W91-11271 5F
tone and District Water Company. W91-11363 4C	W91-10630 5F	
	Elimination of Coliphages, Clostridium perfrin-	Situation of Water Supply in the New Lander of the Federal Republic of Germany.
Radon in Homes Following Its Reduction in a Community Water Supply. W91-11464 5B	gens and Human Enteric Viruses During Drink- ing Water Treatment: Results of Large Volume	W91-11272 5F
	Samplings. W91-10654 5F	Investigations With Electrodialysis Reversal for the Treatment of Surface Water to Make-Up
Design and Performance of the BIOFISH Water Recirculation System.		Water.
W91-11548 5D	Adsorption of Viruses by Diatomaceous Earth Coated with Metallic Oxides and Metallic Per- oxides.	W91-11368 5F
WATER SUPPLY DEVELOPMENT Municipal Ground Water from Ancient Crystal-	W91-10659 5A	Radioactivity in Water Treatment Wastes: A USEPA Perspective.
line Bedrock.	Effectivity of Chlorine Dioxide to Control Aer-	W91-11461 5B
W91-10822 2F Socio-Economic Impact of Improved Wells in	omonas in Drinking Water Distribution Systems. W91-10677 5F	Evaluating Aeration Technology for Radon Removal.
Rural Sierra Leone.	Chlorine Besistance of Motile Assessment and	W91-11462 5F
W91-11358 6B	Chlorine Resistance of Motile Aeromonas spp. W91-10678 5F	Francisco of Chloroland and Baland Com
Avalon Lakes: An Environmental Opportunity. W91-11362 6G	Comparative Inactivation of Hepatitis A Virus	Formation of Chlorophenols and Related Com- pounds In Natural and Technical Chlorination Processes.
WATER TABLE AQUIFERS	and Other Enteroviruses in Water by Iodine. W91-10679 5F	W91-11508 5B
Computation of Average Seasonal Groundwater Flows in Phreatic Aquifer-River System.	UV Disinfection: Short Term Inactivation and	Design and Performance of the BIOFISH Water
W91-10910 2F	Revival.	Recirculation System.
WATER TRANSFER	W91-10680 5F	W91-11548 5D
Review of Interbasin Water Transfers with Spe-	Disinfection Capability in Water for Swimming	WATER TREATMENT FACILITIES
cific Attention to Biota. W91-11013 6B	and Bathing Pools: A Simple Method for Their Evaluation in Practice.	Criteria for Flocculator Design. W91-11269 5F
Water Market in the Southern Front Range of	W91-10684 5F	WATER USE
Colorado.	Fiscal Year 1988 Supported Liquid Membrane	Land Use, Water Use, Streamflow Characteris-
W91-11055 6D  Decision Support System for Water Transfer	Development Report. W91-10727 5G	tics, and Water-Quality Characteristics of the Charlotte Harbor Inflow Area, Florida.
Evaluation.	Demousl of Humio Substances and Alone by	W91-10771 4C
W91-11226 6A	Removal of Humic Substances and Algae by Dissolved Air Flotation.	Water Use Reductions from Retrofitting Indoor
WATER TREATMENT	W91-10751 5F	Water Fixtures.
Special Report: Water Supply and Sanitation. W91-10482 5F	Computer Modeling of Scale Formation During	W91-10811 6D
Waterborne Disease Outbreak.	Treatment of Ground Water in Air Strippers.	Residential Water Conservation: Casa Del Agua.
W91-10615 5C	W91-10798 5G	W91-10814 3D
Causes of Waterborne Outbreaks in the United States.	Bacteriophages as Model Viruses in Water Quality Control.	Cooperative Data on Regional Water Use: The Great Lakes Regional Water Use Data Reposi-
W91-10616 5B	W91-10883 5G	tory.
Thames Water's Experiences with Cryptospori-	Algicidal and Chemical Effect of u.vRadiation	W91-11010 6D
dium.	of Water Containing Humic Substances. W91-10941 5F	What Stakeholders Want and Why.
W91-10617 5C		W91-11035 6A
Prospective Epidemiological Study of Drinking Water Related Gastrointestinal Illnesses.	Removal of Biota from Inter-Basin Transfer Water. W91-11017 5F	Past, Present, and Future of Water Use and Management.
W91-10618 5B		W91-11209 4A
Use of Risk Assessment for Development of Microbial Standards. W91-10619 5G	Home Water Treatment: Remediating Aldicarb Contamination in Suffolk County, New York. W91-11189 5F	Water Use of a Winter Wheat Cultivar (Triticum Aestivum).
		W91-11436 3F
Public Health Criteria for the Aquatic Environ- ment: Recent WHO Guidelines and Their Appli-	Bubbleless Aeration. W91-11222 5G	Student Water Use. W91-11460 6D
cation. W91-10620 5G	Package Water Plant Filters to 0.02 N.T.U.	
Need for New Microbiological Water Quality	W91-11225 5F	WATER USE EFFICIENCY Water Use Reductions from Retrofitting Indoor
Criteria.	Flocculation of Micro-organisms.	Water Fixtures.
W91-10621 5F	W91-11267 5F	W91-10811 6D

WATER HOPE	VI. 1	HIPPR GOLDBOT
WATER USERS	Hydrogeochemical Processes Controlling Sub-	WEED CONTROL
Water Use Reductions from Retrofitting Indoor	surface Transport from an Upper Subcatchment	Testing of Cellular Concrete Revetment Blocks
Water Fixtures.	of Walker Branch Watershed During Storm	Resistant to Growths of Reynoutria japonica
W91-10811 6D	Events. 2. Solute Transport Processes.	Houtt (Japanese Knotweed).
WATER WARON	W91-10908 5B	W91-10942 8F
WATER VAPOR		
Satellite-Derived Integrated Water-Vapor Dis-	Dynamic Model of Caesium Transport in Lakes	WELL CONSTRUCTION
tribution in Oceanic Midlatitude Storms: Varia-	and Their Catchments.	Installation of the Westbay Multiport Ground-
tion with Region and Season.	W91-10934 5B	Water Sampling System in Well 699-43-42K
W91-11419 2B		Near The 216-B-3 Pond.
1171 11417	Seasonal Changes in the Sanitary Bacterial Qual-	
WATER YIELD	ity of Water Draining a Small Upland Catch-	W91-10720 7B
Geohydrologic Evaluation of Spring Sites at	ment in the Yorkshire Dales.	Method for Installing Miniature Multilevel Sam-
Social Circle, Georgia, December 5-8, 1988.	W91-10935 5B	pling Wells.
W91-10767 2F		W91-10962 5A
	Maximum Entropy View of Probability-Distrib-	W71-10702 5/4
WATERFLEAS	uted Catchment Models.	WELL FUNCTION
Alternating Dynamics of Rotifers and Daphnia		
	W91-10965 2A	Discrete-Kernel Method for Simulating Pump-
magna in a Shallow Lake.		ing Tests in Large-Diameter Wells.
W91-10898 2H	Watershed-Based Conservation Programs is the	W91-10998 2F
	Public Getting Its Money's Worth.	
History of Cladocera in the Kleiner Barsch-See,	W91-11044 6C	WELL HYDRAULICS
an Acidic, Calcium-Poor, Marshy Pond in the	117111017	
Middle European Flatland (Die Geschichte der	Strategic Issues in Watershed Development.	Delineation of Traveltime-Related Capture
Cladocerenfauna des Kleinen Barsch-Sees, eines		Areas of Wells Using Analytical Flow Models
	W91-11564 4D	and Particle-Tracking Analysis.
Sauren, Kalkarmen Moorweihers im Mitteleuro-		W91-10957 2F
paischen Flachland).	WAVE EFFECTS	11 71 10701
W91-11515 2H	Fluidization of Marine Mud by Waves.	WELL LOGS
WATERFOWL	W91-10533 5B	Hydrogeologic Inferences from Drillers' Logs
		and from Gravity and Resistivity Surveys in the
Subchronic Hepatotoxicity of Selenomethionine	WEATHER FORECASTING	Amargosa Desert, Southern Nevada.
Ingestion in Mallard Ducks.	Persistent Patterns of Thunderstorm Activity in	W91-10996 5E
W91-10838 5C	the Central United States.	W91-10990 3E
WATERLOGGING	W91-11411 2B	WELL WATER
Soil Water Dynamics Related to Waterlogging		Bacteriological Suitability of Water from Basrah
	Spring and Summer 1988 Drought over the	Wells for Drinking.
in a Sloping Catchment.	Contiguous United States-Causes and Predic-	W91-10629 5A
W91-10906 2G	tion.	W 51-10025
		TT TIL . TP
Hydrological Consequences of Artificial Drain-	W91-11412 2B	Home Water Treatment: Remediating Aldicarb
age of Grassland.		Contamination in Suffolk County, New York
W91-11347 2G	Assessment of VAS-Derived Retrievals and Pa-	W91-11189 5F
W91-11347	rameters used in Thunderstorm Forecasting.	
WATER COMPANY AND A STATE OF THE SECOND	W91-11423 2B	Evaluating Aeration Technology for Radon Re-
WATERSHED MANAGEMENT	1171-11425	
Iterative Evaluation of a Lake Water Quality	WEATHER PATTERNS	moval.
Management Program.		W91-11462 5F
W91-10808 5G	Persistent Patterns of Thunderstorm Activity in	
1171-10000	the Central United States.	WELL YIELD
Buffer Strips to Protect Water Supply Reser-	W91-11411 2B	Embedding and Response Matrix Techniques for
	***************************************	Maximizing Steady-State Ground-Water Extrac
voirs: A Model and Recommendations.	Four Bossester Madel for the Estimation of	
W91-10816 5G	Four-Parameter Model for the Estimation of	tion; Computational Comparison.
	Rainfall Frequency in South-West England.	W91-10954 2F
National Program for Soil and Water Conserva-	W91-11415 2B	
tion. Its Effect on USDA Services.		WELLS
	Spatial Distribution of Rainfall in the Greater	Wellhead Protection-Information and Re
W91-11169 3F	Athens Area.	
		sources.
Legislative Implementation of Integrated Catch-	W91-11416 2B	W91-11172 5G
ment Management in Western Australia.		
W91-11374 6E	Kinematic, Dynamic, and Thermodynamic	Wellhead Protection in Massachusetts: Protect
	Analysis of a Weakly Sheared Severe Thunder-	ing Public Water Supplies from Pesticide Im
Watershed Development in Asia: Strategies and	storm over Northern Alabama.	
		pacts.
Technologies.	W91-11417 2B	W91-11182 5C
W91-11563 6B		
	Numerical Simulations of the Evolution of a	Response of Water Level in a Well to a Time
Strategic Issues in Watershed Development.	Cold Front and its Precipitation.	Series of Atmospheric Loading Under Confined
W91-11564 4D	W91-11418 2B	Conditions.
	W 71-11410	
Revegetation Technologies.	C. W. D. L. I. L. L. L. I. W. L. W. L. Die	W91-11236 21
W91-11568 4D	Satellite-Derived Integrated Water-Vapor Dis-	
W 51-11300	tribution in Oceanic Midlatitude Storms: Varia-	Evaluation of Analytical Solutions to Estimat
Land Towns James in Watershad Davidsament	tion with Region and Season.	Drawdowns and Stream Depletions by Wells
Land Tenure Issues in Watershed Development.	W91-11419 2B	W91-11240 21
W91-11569 6F	W71-11417	W 21-11240
	Squall I ine in Southern Garmany, Financias	Casia Economic Impact of Impact Malla S
Framework for Planning, Monitoring, and Eval-	Squall Line in Southern Germany: Kinematics	Socio-Economic Impact of Improved Wells in
uating Watershed Conservation Projects.	and Precipitation Formation as Deduced by Ad-	Rural Sierra Leone.
W91-11570 6B	vanced Polarimetric and Doppler Radar Meas-	W91-11358 6
W71-113/0 0B	urements.	
WATERCHERO	W91-11420 2B	Deforestation and Leaching of Nitrogen as Ni
WATERSHEDS	W >1-11920 2B	trates into Underground Water in Intertropica
Soil Water Dynamics Related to Waterlogging		
in a Sloping Catchment.	Sensitivity Studies of Tropical Storm Genesis	Zones: The Example of Cote d'Ivoire.
W91-10906 2G	Using a Numerical Model.	W91-11446 21
W 71-10700 2G	W91-11421 2B	
Hydrogeochemical Processes Controlling Sub-		Evaluation of Site-Selection Criteria, We
	WEATHERING	Design, Monitoring Techniques, and Cost Ana
surface Transport from an Upper Subcatchment	WEATHERING	
of Walker Branch Watershed During Storm	Kinetics of Chemical Weathering in B Horizon	ysis for a Ground-Water Supply in Piedmon
Events. 1. Hydrologic Transport Processes.	Spodosol Fraction.	Crystalline Rocks, North Carolina.
W01 10007 SB	W91-11233 5C	W91-11596 21

## WEST AFRICA

WEST AFRICA	Sauren, Kalkarmen Moorweihers im Mitteleuro-	Review of Fisheries Habitat Improvement
Deforestation and Leaching of Nitrogen as Ni- trates into Underground Water in Intertropical	paischen Flachland). W91-11515 2H	Projects in Warmwater Streams, with Recom- mendations for Wisconsin.
Zones: The Example of Cote d'Ivoire.	WETLANDS TREATMENT	W91-11591 2H
	Environmental Feasibility of Using Wetlands to	WOLF CREEK
WET AIR REGENERATION Evaluation of Full Scale Activated Sludge Sys-	Treat Runoff Pollution. W91-10737 5D	Channel and Bank Stability of Wolf Creek and a
tems Utilizing Powdered Activated Carbon Ad-		Tributary at U.S. Highway 45 Near Wheeler, Prentiss County, Mississippi.
dition with Wet Air Regeneration.	WHEAT Water Use of a Winter Wheat Cultivar (Triti-	W91-11107 2E
W91-11099 5D	cum Aestivum).	WOOD RIVER BASIN
WET DEPOSITION	W91-11436 3F	Hydrogeology, Water Quality, and Ground-
Sequential Sampling of Particles, Major Ions and	WHITE WATER	Water Development Alternatives in the Lower
Total Trace Metals in Wet Deposition. W91-11249 5B	Closing Paper Mill Whitewater Circuits by In-	Wood River Ground-Water Reservoir, Rhode
	serting an Anaerobic Stage with Subsequent Treatment.	Island. W91-11572 2F
WET OXIDATION PROCESS  Wet Oxydation as the Alternative for Sewage	W91-11477 5G	
Sludge Treatment.	WHITMOYER LABORATORIES SITE	WOOD WASTES Treatment and Detoxification of Aqueous
W91-11146 5D	Superfund Record of Decision: Whitmoyer Lab-	Spruce Bark Extracts by Aspergillus niger.
WETLAND IMPOUNDMENTS	oratories, PA.	W91-11481 5D
Wetland Impoundments of East-Central Florida.	W91-11582 5G	WYOMING
W91-10854 2L	WILDLIFE	Point-Infiltration Model for Estimating Runoff
WETLAND WASTE TREATMENT	Atrazine Hazards to Fish, Wildlife, and Inverte-	from Rainfall on Small Basins in Semiarid Areas
Sewage Treatment with Plants.	brates: A Synoptic Review. W91-10709 5C	of Wyoming.
W91-11466 5D		W91-11585 2E
WETLANDS	WIND Meteorology and Oceanography in the Seto	XYLENES
Seasonal Variation of Biomass and Production	Inland Sea.	Drinking Water Criteria Document on Xylene.
Dynamics for Above and Belowground Compo- nents of a Spartina alterniflora Marsh in the	W91-10520 2L	W91-10757 3C
Euhaline Sector of Paranagua Bay (SE Brazil).	WIND CAVE NATIONAL PARK	YAMPA RIVER VALLEY
W91-10495 2L	Use of Electronic Data-Logging Equipment to	Effect of Decoupled Low-Level Flow on Winter Orographic Clouds and Precipitation in
Water Futures.	Monitor Hydrologic Parameters in a Humid Cave Environment in Wind Cave National Park.	the Yampa River Valley.
W91-10506 6B	South Dakota.	W91-11410 2B
Managing Oregon's Estuarine Resources Lands.	W91-11389 7B	YANGTZE RIVER
W91-10508 2L	WIND-DRIVEN CURRENTS	Studies on the Situation of Pollution and Coun-
Strategies for Restoring and Developing Fish	Three-Dimensional Numerical Modelling of	termeasures of Control of the Oceanic Environ-
Habitats in the Strait of Georgia: Puget Sound	Wind-Driven Circulation in a Shallow Homoge- neous Lake.	ment in Zhoushan Fishing Ground: The Largest Fishing Ground in China.
Inland Sea, Northeast Pacific Ocean.	W91-10992 2H	W91-10559 5C
W91-10568 5G	WIND EROSION	WIGON INT
Environmental Feasibility of Using Wetlands to	Advances in Wind and Water Erosion Predic-	YUGOSLAVIA Conceptual Framework of Environmental Man-
Treat Runoff Pollution. W91-10737 5D	tion. W91-10509 2J	agement Strategies for Yugoslavia: The Case of
	W91-10509 2J	the Adriatic Sea.
Fate of Silicate Minerals in a Peat Bog. W91-10789 2H	WISCONSIN	W91-10584 5G
W91-10/69 2H	Species Composition of Fish Communities in Northern Wisconsin Lakes: Relation to pH.	ZEOLITES
Wetland Impoundments of East-Central Florida.	W91-10725 5C	Removal of Heavy Metals and Other Cations
W91-10854 2L	Superfund Record of Decision. Mid-State Dis-	From Wastewater Using Zeolites. W91-11369 5D
Balance of Nutrient Losses and Gains in Sea-	posal Landfill, WI.	
grass Meadows. W91-10867 2L	W91-10749 5G	ZINC
	Monthly Mean Discharge at and Between Se-	Voltammetric Determination of the Complexa- tion Parameters of Zinc in Marine and Estuarine
Visual Interpretation of a Landsat Mosaic of the Okavango Delta and Surrounding Area.	lected Streamflow-Gaging Stations Along the	Waters.
W91-10879 2H	Mississippi, Minnesota, and St. Croix Rivers, 1932-87.	W91-10924 2K
Groundwater Flow and the Metal Content of	W91-10760 2E	Measurement of the Different Forms of Zinc in
Peat.	Estimation of Phosphorus Exchange Between	Narragansett Bay Water Based on the Rate of
W91-10902 2F	Littoral and Pelagic Zones During Nighttime	Uptake by a Chelating Resin. W91-10926 2K
Social and Private Returns from Wetland Pres-	Convective Circulation. W91-10863 2H	
ervation.		Concentration of Metals in Various Larval Stages of Four Ephemeroptera Species.
W91-11057 5G	Geochemical Evolution in the Cambrian-Ordo- vician Sandstone Aquifer, Eastern Wisconsin: 1.	W91-11302 5B
Dendrogeomorphic Approach to Measurement	Major Ion and Radionuclide Distribution.	Heavy Metal Distribution in the Godvari River
of Sedimentation in a Forested Wetland, Black Swamp, Arkansas.	W91-10953 2K	Basin.
W91-11397 2H	Tritium as an Indicator of Ground-Water Age in	W91-11445 5B
Impact of Carbon Dioxide and Ammonium on	Central Wisconsin.	ZOOPLANKTON
the Growth of Submerged Sphagnum cuspida-	W91-10958 2F	Zooplankton Effects on Phytoplankton in Lakes
tum.	Effects of the 1988 Drought on Water Resources	of Contrasting Trophic Status. W91-10859 2H
W91-11452 2H	in Wisconsin. W91-11108 2E	
History of Cladocera in the Kleiner Barsch-See,		Rotifers of the Genus Synchaeta-An Important
an Acidic, Calcium-Poor, Marshy Pond in the Middle European Flatland (Die Geschichte der	Wisconsin's Risk Assessment Based Numerical Groundwater Standards Program.	Component of the Zooplankton in the Coasta Waters of the Southern Baltic.
Cladocerenfauna des Kleinen Barsch-Sees, eines	W91-11183 5G	W91-11519 2L

2L

# **AUTHOR INDEX**

ABAD, F. X.	ALBAIGES, J.	ALLISON, R. W.
Concentration of Hepatitis A Virus in Environ-	Volatile Organic Compounds in Two Polluted	Effects of Chlorination Conditions On the AOX
mental Samples.	Rivers in Barcelona (Catalonia, Spain).	and Chlorinated Phenol Content of Kraft Bleach
W91-10658 5A	W91-10887 5B	Plant Wastewaters.
ADDE C D	AT DEDT M	W91-11474 5D
ABBE, G. R. Pathways of Silver Uptake and Trophic Trans-	ALBERT, M. Recovery of Enterovirus from Primary Sludge	ATACONA DE SE
fer in Estuarine Organisms.	Using Three Elution Concentration Procedures.	ALMEMARK, M.
W91-11337 5B	W91-10657 5A	Treatment Technologies for Organochlorine- Containing Sludges and Concentrates from Ex-
		ternal Treatment of Pulp and Paper
ABDEL-MOATI, A. R.	ALCOLADO, P. M.	Wastewaters.
Patella vulgata, Mytilus minimus and Hyale pre-	Ecological Assessment of Semi-Enclosed Marine	W91-11500 5D
vosti as Bioindicators for Pb and Se Enrichment	Water Bodies of the Archipelago Sabana-Cama- guey (Cuba) Prior to Tourism Development	(See Alare or
in Alexandria Coastal Waters. W91-10875 5A	Projects.	ALONSO, I.
W91-106/3	W91-10566 6G	Sediment Transport on the Foreshore.
ABDUL, A. S.		W91-10599 2L
Aqueous Surfactant Washing of Residual Oil	ALDER, A.	ALONSO, J. L.
Contamination from Sandy Soil.	Pathway Analysis of Selected Organic Chemi-	Enumeration of Motile Aeromonas in Valencia
W91-10796 5G	cals from Sewage to Agricultural Soil.	Coastal Waters by Membrane Filtration.
ABE, K.	W91-11123 5B	W91-10636 5B
Investigation on Turbidity and Flow Patterns in	ALEXANDER, L. M.	
Half-Closed Sea Area.	PCR and Environmental Monitoring: The Way	ALVAREZ, A.
W91-10532 5B	Forward.	Method to Determine the Formation Constants
	W91-10670 5A	of Leaky Aquifers, and Its Application to Pump-
ABELIOVICH, A.	ALEXANDER, M.	ing Test Data. W91-10961 7C
Denitrification in Laboratory Sand Columns: Carbon Regime, Gas Accumulation and Hy-	Biodegradation of Chemicals at Trace Concen-	W91-10901
draulic Properties.	trations.	AMAJOR, L. C.
W91-11330 5G	W91-11102 5B	Aquifers in the Benin Formation (Miocene-
W71-11330		Recent), Eastern Niger Delta, Nigeria: Lithos-
ABRIOLA, L. M.	ALEXANDER, R. B.	tratigraphy, Hydraulics, and Water Quality.
Theoretical Study of the Significance of None-	Methodology to Derive Water-Quality Trends for Use by the National Water Summary Pro-	W91-11443 2F
quilibrium Dissolution of Nonaqueous Phase	gram of the U.S. Geological Survey.	AMANATIDIS, G. T.
Liquids in Subsurface Systems.	W91-11110 7B	Spatial Distribution of Rainfall in the Greater
W91-11228 5B	75	Athens Area.
AHLERT, R. C.	ALEXANDER, T. W.	W91-11416 2B
Migration and Treatment of a Dense Aqueous	Analysis of Alternative Modifications for Re-	
Contaminant Source and Plume.	ducing Backwater Flooding at the Honey Creek	AMBROZ, T.
W91-11380 5G	Coal Strip Mine Reclamation Site in Henry	Pesticide Rinseate Management Plan.
AUT DICTIO 1 C	County, Missouri. W91-11595 2E	W91-11195 5G
AHLRICHS, J. S.  AgriSource: The Information System for Crop	W 91-11393	AMBRUS, S. Z.
Technology.	Delineation of Flooding within the Ozark Na-	Flood Forecasts on Transboundary Rivers in
W91-11196 10D	tional Scenic Riverways in Southeastern Missou-	Hungary with Parallels in Canada.
	ri-Akers and Alley Spring.	W91-11015 4A
AHRING, B. K.	W91-11578 2E	
Anaerobic Degradation of PCP and Phenol In	Delineation of Flooding within the Ozark Na-	AMOROS, I.
Fixed-Film Reactors: The Influence of an Addi-	tional Scenic Riverways in Southeastern Missou-	Enumeration of Motile Aeromonas in Valencia
tional Substrate. W91-11512 5D	riRound Spring and Powder Mill.	Coastal Waters by Membrane Filtration.
W91-11312 3D	W91-11579 2E	W91-10636 5B
AHTIAINEN, J.		ANDERSON, C. L.
Staphylococci in Polluted Waters and in Waters	ALEYA, L.	Scour at Cantilevered Pipe Outlets, Plunge, Pool
of Uninhabited Areas.	Ecophysiological Significance of the Diel Bio- chemical Changes of Particulates Coupled with	Energy Dissipator Design Criteria.
W91-10631 5B	Metabolic and Environmental Parameters in	W91-10722 8B
AICHBERGER, K.	Two Trophically Different Lakes.	AND TO SOLVE A
Effects of Sewage Sludge and Waste Compost	W91-10896 2H	ANDERSON, H. A. Wisconsin's Risk Assessment Based Numerical
on Some Soil Enzymatic Activities Tested in a		Groundwater Standards Program.
Field Experiment.	ALI, N.	W91-11183 5G
W91-11151 5E	Development of Small Hydro for Remote Areas	W. 21-11100
A TA COMPANY OF	of Northern Pakistan. W91-11215 8C	ANDERSON, J. L.
AINSWORTH, L.	W91-11215 8C	Soil Survey Information System: A User Friend-
Package Water Plant Filters to 0.02 N.T.U. W91-11225 5F	ALLEE, D.	ly Soil Information System.
W91-11223	Willingness-to-Pay for Protection of Water Sup-	W91-11174 7C
AIREY, D. D.	plies in Four Massachusetts' Towns.	ANDERSON M
Impact of Titanium Dioxide Waste on Fertiliza-	W91-11056 6C	ANDERSON, M.  Ambient Air Co-Modeling in Alaska.
tion in the Sea Urchin Echinometra mathaei.	ATTER D. T	W91-11070 70
W91-10870 5C	ALLEE, D. J.  Breaking the Incrementalist Trap: Achieving	
AKAGI, S.	Unified Management of the Great Lakes Ecosys-	ANDERSON, R. N.
Formation of Oxygen-Deficient Water Mass in	tem.	Analysis and Interpretation of the Borehold
Omura Bay.	W91-11025 6A	Televiewer Log: Information on the State o
W91-10592 5B		Stress and the Lithostratigraphy at Hole 504B
	ALLEN, R. D.	W91-11549 70
AKAI, K.	Relationship of Regional Water Quality to Aqui-	ANDERSON, T. A.
Water Quality Purification System for the En-	fer Thermal Energy Storage.	
closed Sea Area.	W91-11082 5C	Volatile and Semivolatile Organics.
W91-10596 5G	ALLEN, V. G.	W91-10712 51
AL-SULAMI, A. A.	Influence of Flooded Soil on Chemical Compo-	
Bacteriological Suitability of Water from Basrah	sition of Annual Ryegrass and Digestibility by	ANDERSON, W. P.
Wells for Drinking.	Meadow Voles.	Minnesota Clean Water Partnership Program
W91-10629 5A	W91-11536 2I	W91-11181 50

## ANDERSSON, P.

ANDERSSON, P.	ARUGA, Y.	AZARMNIA, H.
Rapid Preconcentration Method for Multiele- ment Analysis of Natural Freshwaters. W91-10892 7B	Seasonal Changes of Organic Carbon and Nitro- gen Production by Phytoplankton in the Estuary of River Tamagawa.	Embedding and Response Matrix Techniques for Maximizing Steady-State Ground-Water Extraction Computational Companies.
W 51-10052	W91-10604 5B	tion; Computational Comparison. W91-10954 2F
ANDERSSON, Y.		W91-10934 2F
Waterborne Disease Outbreak.	ASOLEKAR, S. R.	AZIMI, A. A.
W91-10615 5C ANDRAS, E.	Kinetics of Chemical Weathering in B Horizon Spodosol Fraction. W91-11233 5C	Influence of Reactor Mixing Characteristics on the Rate of Nitrification in the Activated Sludge
Anaerobic Toxicity of Fines In Chemi-thermo-		Process.
mechanical Pulp Wastewaters: A Batch Assay- Reactor Study Comparison.	ASOWATA, C. Determination of Nitroaromatics and Nitramines	W91-10932 5D
W91-11479 5D	in Ground and Drinking Water by Wide-Bore	AZOV, Y.
TWO and Challes Asses (DTDA) and Asses	Capillary Gas Chromatography. W91-11262 5A	Eastern Mediterranean: A Marine Desert.
Effect of a Chelating Agent (DTPA) on Anaero- bic Wastewater Treatment in an Upflow Sludge	ASTIER, J. M.	W91-10553 2H
Blanket Filter. W91-11277 5D	Impact of Coastal Development on the Infralit- toral Zone Along the Southeastern Mediterrane-	BAEYENS, W.  Behavior of Heavy Metals in a Mud Flat of the
ANDREAE, M. O. Methyl and Butyltin Compounds in Water and	an Shore of Continental France. W91-10562 6G	Scheldt Estuary, Belgium. W91-10872 5B
Sediments of the Rhine River.	ASUQUO, F. E.	BAH, O. M.
W91-11335 5B	Tar Balls on Ibeno-Okposo Beach of South-East Nigeria.	Socio-Economic Impact of Improved Wells in
ANG, C. C.	W91-10876 5B	Rural Sierra Leone.
Aqueous Surfactant Washing of Residual Oil Contamination from Sandy Soil.	ATA, O.	W91-11358 6B
W91-10796 5G	Regional-Wide Waste Disposal Project on Sea-	BAHR, J. M.
ANGELL, J. K.	coast of Enclosed Coastal Sea. W91-10594 5E	Geochemical Evolution in the Cambrian-Ordo- vician Sandstone Aquifer, Eastern Wisconsin: 1.
Relation of Atmospheric CO2 to Tropical Sea		Major Ion and Radionuclide Distribution.
and Air Temperatures and Precipitation. W91-11002 2B	ATPUTHANATHAN, C. S. Soil Water Dynamics Related to Waterlogging	W91-10953 2K
	in a Sloping Catchment.	BAIR, E. S.
ANGERMEIER, P. L.	W91-10906 2G	Delineation of Traveltime-Related Capture
Assessing Stream Values: Perspectives of Aquat- ic Resource Professionals.	ATREYA, N. C.	Areas of Wells Using Analytical Flow Models
W91-11425 8I	Solid-Phase Extraction for Multi-Residue Analy- sis of Some Triazole and Pyrimidine Pesticides	and Particle-Tracking Analysis. W91-10957 2F
APROSI, G.	in Water.	BAKKE, T.
Interrelations Between Amoebae and Bacteria in the Moselle River, France.	W91-11313 5A ATTA, M. M.	Biotechnology Degradation and Mitigation of
W91-10650 5B	Patella vulgata, Mytilus minimus and Hyale pre-	Offshore Oil Spills, Phase 1. Main Report: Technology to Enhance Biodegradation of Oil Spills
APTS, C. W. Confirmatory Chemical Analyses and Solid	vosti as Bioindicators for Pb and Se Enrichment in Alexandria Coastal Waters.	State of the Art and Perspectives for Technology Development.
Phase Bioassays on Sediment from the Columbia	W91-10875 5A	W91-10735 5G
River Estuary at Tongue Point, Oregon. W91-10753 5B	ATWATER, J. Waste Disposal Facilities and Community Re-	BALAMURUGAN, G.
ARAI, T.	sponse: Tracing Pathways from Facility Impacts to Community Attitude.	Urbanization and Urban Water Problems in Southeast Asia: A Case of Unsustainable Devel-
Studies on the Bacterial Fauna of the Tamagawa River.	W91-11280 5E	opment. W91-11263 6G
W91-10632 5B	AUBIN, A. J.	W91-11203
ARAUJO FILHO, M. C.	Transformation of (C-14)-2,4-Dichlorophenol in	BALBA, A. M.
Mathematical Modelling for Reservoir Water-	Saskatchewan Soils. W91-10922 5B	Lead Sorption in Calcareous Soils.
Quality Management Through Hydraulic Struc-		W91-11453 5B
tures: A Case Study. W91-10490 5G	AULT, K. A.  Effects of Land Use Alteration on Tropical	BALDRY, M. G. C.
ARMENTANO, T. V.	Carbon Exchange. W91-11072 4C	Activity of Peracetic Acid on Sewage Indicator Bacteria and Viruses.
Effects of Land Use Alteration on Tropical		W91-10683 5D
Carbon Exchange.	AUSTIN, T. A.	
W91-11072 4C	Characteristics of Rhodamine WT and Fluores- cein as Adsorbing Ground-Water Tracers.	BALEUX, B.  Aeromonas Species Stabilization Ponds in the
ARMSTRONG, A. C.	W91-10952 5B	Arid Region of Marrakesh, Morocco, and Rela-
Hydrological Consequences of Artificial Drain- age of Grassland.	AUTY, D.	tion to Fecal-Pollution and Climatic Factors. W91-10842 5D
W91-11347 2G	Destruction of Faecal Bacteria, Enteroviruses and Ova of Parasites in Wastewater Sludge by	
ARNDT, H.	Aerobic Thermophilic and Anaerobic Mesophi-	Dynamics of Non-01 Vibrio cholerae in Experi- mental Sewage Stabilization Ponds Under Arid
Rotifers of the Genus Synchaeta-An Important Component of the Zooplankton in the Coastal	lic Digestion. W91-10688 5D	Mediterranean Climate.
Waters of the Southern Baltic.	AXLER, R. P.	W91-10690 5D
W91-11519 2L	Increased Precipitation Acidity in the Central	BALINOV, I.
ARNOW, T.  Hydrologic Characteristics of the Great Salt	Sierra Nevada. W91-10471 5B	Determination of Herbicide Residues in Soil in the Presence of Persistent Organochlorine Insec-
Lake, Utah: 1847-1986.	AYERS, M. A.	ticides.
W91-11597 2H	Simulated Hydrologic Effects of Climatic	W91-11310 5A
ARSEN'EV, G. S.	Change in the Delaware River Basin. W91-11060 5C	BALINOVA, A. M.
Selection of the Operating Regime of the Onega-		Determination of Herbicide Residues in Soil in
Svir' Water System Under Conditions of In- creasing Water Consumption.	Simulation of Precipitation by Weather Type Analysis.	the Presence of Persistent Organochlorine Insec- ticides.
W91-11288 6D	W91-11230 2B	

BALINT, G.	Conductivity and Oxygen in the River Butron	Japanese Knotweed (Reynoutria japonica
Flood Forecasts on Transboundary Rivers in Hungary with Parallels in Canada.	Basin. W91-11403 5C	Houtt). W91-10852 4A
W91-11015 4A	BATEMAN, B. W.	DECIDENC A
BALL, J. T. Assessment of the Salinity Tolerance of Eight	Comparison of Methods for the Isolation of a Wide Range of Viruses from Shellfish.	BEHRENS, A.  Measures for Purification of the Leachate from 'Renseanlage Damhusaen' into Copenhagen
Sonoran Desert Riparian Trees and Shrubs.	W91-10698 5A	Waters, to Meet the NPO-Plan.
W91-10752 3C	BATIE, S. S.	W91-10601 5D
BANERJEE, A. K.	Ground Water Contamination from Agricultural	BEKER, D.
Revegetation Technologies. W91-11568 4D	Sources: Implications for Voluntary Policy Ad- herence from Iowa and Virginia Farmer's Atti-	Environmental Aspects of Landfilling Sludge.
	tudes.	W91-11136 5E
BARILE, G. Influence of Polyelectrolyte Characteristics on	W91-11437 5G	BELITZ, K.
Sludge Conditioning (Lab Evaluations).	BATTAGLIA, B.	Calibration of a Texture-Based Model of a
W91-10701 5D BARKER, J. A.	Effects of Pollution on Heterozygosity in the Barnacle Balanus amphitrite (Cirripedia: Thora-	Ground-Water Flow System, Western San Joa- quin Valley, California.
Discrete-Kernel Method for Simulating Pump-	cica). W91-10518 5C	W91-11101 5B
ing Tests in Large-Diameter Wells. W91-10998 2F	BATTAGLIN, W. A.	Character and Evolution of the Ground-Water Flow System in the Central Part of the Western
	Effects of Land-Use Buffer Size on Spearman's	San Joaquin Valley, California.
BARKLEY, W. A. Biological Dehalogenation of Kraft Mill	Partial Correlations of Land Use and Shallow Ground-Water Quality.	W91-10772 2F
Wastewaters.	W91-10761 4C	BELKIN, S.
W91-11497 5D	BATTEESE, R. I.	Denitrification in Laboratory Sand Columns:
BARKO, J. W.	Returnable Pesticide Containers: Maine's Depos-	Carbon Regime, Gas Accumulation and Hy- draulic Properties.
Estimation of Phosphorus Exchange Between Littoral and Pelagic Zones During Nighttime	it and Collection System.	W91-11330 5G
Convective Circulation.	W91-11191 5G	
W91-10863 2H	BAUMGRASS, L.	BELL, P. R. F.  Status of Eutrophication in the Great Barrier
BARNES, G. M.	Permeability of Soils with Organic Fluids.	Reef Lagoon.
Convective Cell in a Hurricane Rainband.	W91-10783 5B	W91-10535 5B
W91-11422 2B	BAYES, C. D.	BELL, W. H.
BARNSTON, A. G.	Alternative Uses of Sludge Other than Agricul-	Environmental Research, Policy and Regula-
Empirical Method of Estimating Raingage and Radar Rainfall Measurement Bias and Resolu-	tural. W91-11120 5E	tion: The Chesapeake Bay Experience. W91-10575 5G
tion.	BEAGLEY, D. P.	DATE TALENT D. A.
W91-11409 2B	Abbeystead Outfall Works: Background to Re- pairs and Modifications and Lessons Learned.	BELLUCK, D. A. Wisconsin's Risk Assessment Based Numerical
BARRETT, J. K. Road Salting Impacts in Massachusetts.	W91-11355 5D	Groundwater Standards Program.
W91-11053 4C	BEARD, K. V.	W91-11183 5G
DARBON W	Laboratory Measurements of Small Raindrop	BELTRAN, L.
BARRON, W.  Hong Kong: Can the Dragon Clean its Nest.	Distortion. Part I: Axis Ratios and Fall Behav-	Health Risk Assessment of Toluene in California
W91-11439 5G	ior. W91-10513 2B	Drinking Water. W91-10741 5C
BARROWS, M. E.		W91-10/41
Confirmatory Chemical Analyses and Solid	BEAVER, J. L. Abbeystead Outfall Works: Background to Re-	BEN AIM, R.
Phase Bioassays on Sediment from the Columbia River Estuary at Tongue Point, Oregon.	pairs and Modifications and Lessons Learned.	Use of a Backflush Technique in Cross-flow Microfiltration for Treating Natural Water and
W91-10753 5B	W91-11355 5D	Filter Backwash Wastewater in Water Works
	BECK, M. B.	W91-11270 5F
BARTON, C. A.  Analysis and Interpretation of the Borehole	Dynamic Simulation of Storm Tanks. W91-10928 5D	BENDER, L.
Televiewer Log: Information on the State of	W91-10928 5D	Pulsed Field Electrophoresis of Genomic Re
Stress and the Lithostratigraphy at Hole 504B.	BECK, R. H.	striction Fragments for the Detection of Noso- comial Legionella pneumophila in Hospital
W91-11549 7C	Soil Tec: A Computerized Soil-Specific Fertiliz- er Application System.	Water Supplies.
BARTRAM, J. K.	W91-11197 7C	W91-10836 5A
Surveillance Solutions to Microbiological Prob- lems in Water Quality Control in Developing	BECKER, N.	BENGTSSON, G.
Countries.	Water Diversion from the Great Lakes as a	Dispersal Dynamics of Groundwater Bacteria
W91-10625 5G	Dynamic Game.	W91-10843 51
BARTSCH, R. A.	W91-11051 6B	BENNET, J.
Selective Concentration of Lead(II) Chloride	BECKER, N. S. C.	Effect of Dissolved Nutrients and Inorganic Sus
Complex With Liquid Anion-Exchange Mem-	Extraction of Heavy Metals from Sludges and Muds by Magnetic Ion-Exchange.	pended Solids on the Survival of E. coli is
branes. W91-11247 5D	W91-11145 5D	Seawater. W91-10638 51
	BEDIENT, P. B.	
BARTZIS, J. G. Spatial Distribution of Rainfall in the Greater	Impact of Recharge Through Residual Oil Upon	BENNETT, P. C.
Athens Area.	Sampling of Underlying Ground Water.	Fate of Silicate Minerals in a Peat Bog. W91-10789 2F
W91-11416 2B	W91-10793 5B	
BARZILY, A.	BEERLING, D. J.	BENNINGER, B. A.
Survival of Pathogenic Bacteria in an Adverse	Testing of Cellular Concrete Revetment Blocks	Water Rate Structure for Demand Managemen in the Regional Municipality of Waterloo.
Environment.	Resistant to Growths of Reynoutria japonica	W91-11049 60
W91-10692 5D	Houtt (Japanese Knotweed). W91-10942 8F	
BASAGUREN, A.		BENSON, R. E. Evaporative Drying of Dredged Material.
Downstream Changes in Caddisfly Composition	Use of Non-Persistent Herbicides, Glyphosate, and 2.4-D Amine, to Control Riparian Stands of	W91-11000 5I

BENTON, C.	BIERMAN, V. J.	DODDOVA A V
	Hazard Assessment Research Strategy for	BODROVA, A. V.
Occurrence of Cryptosporidium spp. Oocysts in	Ocean Disposal.	Characteristics of Mining Quarries on Hydrau-
Scottish Waters, and the Development of a		lic-Fill Dumps.
Fluorogenic Viability Assay for Individual	W91-11551 5E	W91-11286 8A
Cryptosporidium Oocysts. W91-10645 5B	BIKSHAM, G.	POURS R
W91-10645 5B	Heavy Metal Distribution in the Godvari River	BOERS, P.
BERES, M.	Basin.	Ion Concentrations in Interstitial Water as Indi-
Application of Ground-Penetrating-Radar Meth-	W91-11445 5B	cators for Phosphorus Release Processes and
ods in Hydrogeologic Studies.		Reactions.
W91-10956 7B	BINGEL, F.	W91-10888 2K
***************************************	Man-Made Garbage Pollution on the Mediterra-	
BERG, G.	nean Coastline.	BOERS, P. C. M.
Saprobiological Investigations on the Bottom	W91-10569 5B	Influence of pH on Phosphate Release from
Flora of the River Recknitz in the Northern Part		Sediments.
of the Mecklenburgian Lake District (GDR)	BIRD, S. C.	W91-11327 2H
(Saprobiologische Untersuchungen an der	Simazine Concentrations in a Stream Draining	
Benthosflora der Recknitz im Norden der Meck-	an Agricultural Catchment.	BOGARDI, I.
lenburger Seenplatte (DDR)).	W91-11364 4C	Decision Support System for Water Transfer
W91-11520 2E		Evaluation.
***************************************	BISHOP, R.	W91-11226 6A
BERG, R. C.	Flood Forecasts on Transboundary Rivers in	
Potential for Aquifer Recharge in Illinois (Ap-	Hungary with Parallels in Canada.	BOHER, S.
propriate Recharge Areas).	W91-11015 4A	Comparison of Two Methods for the Recovery
W91-11580 7C		of Rotavirus from Mussels and Oysters.
	BITTON, G.	W91-10697 5A
BERGAMETTI, G.	Laboratory Studies of Virus Survival During	
Major Ions in Marine Rainwater With Attention	Aerobic and Anaerobic Digestion of Sewage	Detoxification by Sephadex LH20 of Seafood
to Sources of Alkaline and Acidic Species.	Sludge.	Concentrates for Rotavirus Assay.
W91-11250 5B	W91-11319 5D	W91-10696 5A
		#71*10090 JA
BERGSTEIN-BEN DAN, T.	BLACK, R.	BOLDENKOV, V. S.
Distribution of Fecal Pollution Indicator Bacte-	Use of the Intertidal Zone by Fish in Nova	The state of the s
ria in Lake Kinneret.	Scotia.	Distribution and Migration of Heavy Metals in
W91-11322 5B	W91-11557 2L	the Environment of the Altai Mountains in Con-
		nection with Ecological Substantiation of the
BERGSTROM, L.	BLACKALL, L. L.	Katun Hydroelectric Station Project.
Modelling Water and Solute Transport in Ma-	Foaming in Activated Sludge Plants: A Survey	W91-11292 5B
croporous Soil. II. Chloride Breakthrough	in Queensland, Australia and an Evaluation of	
Under Non-Steady Flow.	Some Control Strategies.	BOLLAG, J.
W91-10804 2G	W91-11328 5D	Microbial Dechlorination of the Herbicide Me-
		tolachlor.
BERIL, C.	BLACKBURN, W. H.	W91-11377 5B
Comparison of Two Methods for the Recovery	Spatial and Temporal Influence of Soil Frost on	
of Rotavirus from Mussels and Oysters.	Infiltration and Erosion of Sagebrush Range-	BOLYGO, E.
W91-10697 5A	lands.	Solid-Phase Extraction for Multi-Residue Analy-
	W91-10820 2G	sis of Some Triazole and Pyrimidine Pesticides
Detoxification by Sephadex LH20 of Seafood		in Water.
Concentrates for Rotavirus Assay.	BLACKWELL, C. D.	W91-11313 5A
W91-10696 5A	Directory of Assistance Centers of the National	# 71-11313
	Water Data Exchange (NAWDEX).	BOMAN, B.
BERNHARDT, H.	W91-11575 10D	Membrane Filtration Combined with Biological
Flocculation of Micro-organisms.		Treatment for Purification of Bleach Plant Ef-
W91-11267 5F	Directory of Member Organizations of the Na-	fluents.
DEDNOTEIN D D	tional Water Data Exchange (NAWDEX).	
BERNSTEIN, B. B.	W91-11574 10D	W91-11490 5D
Marine Monitoring in Heterogeneous Environ-	DI ATOMPT T TITL	BOMBOI, M. T.
ments.	BLAISDELL, F. W.	
W91-11264 5A	Scour at Cantilevered Pipe Outlets, Plunge, Pool	Hydrocarbons in Urban Runoff: Their Contribu-
BERON, L. E.	Energy Dissipator Design Criteria.	tion to the Wastewaters.
	W91-10722 8B	W91-10885 5E
Features of the Limnological Behavior of Salto	DI ADD C	POOTU P
Grande's Reservoir (Argentina-Uruguay).	BLARR, S.	BOOTH, R.
W91-10491 5C	Buffer Strips to Protect Water Supply Reservoirs: A Model and Recommendations.	Effect of Coal-Mine Effluent on Fungal Assem-
BERRY, C.		blages and Leaf Breakdown.
Effect of Heat Shock on Recovery of Escheri-	W91-10816 5G	W91-11320 5C
chia coli from Drinking Water.	BLEED, A.	DOOTTI INON A
W91-10628 5F		BOOTHANON, S.
77-10020	Decision Support System for Water Transfer Evaluation.	Use of a Backflush Technique in Cross-flow
BESTER, D.		Microfiltration for Treating Natural Water and
Evaluation of Fecal Enterococci Isolation Media	W91-11226 6A	Filter Backwash Wastewater in Water Works
to Indicate Fecal Pollution in Chlorinated		W91-11270 5F
	BLOCK, M.	
Water.	BLOCK, M. Decreased Noreninephrine and Eninephrine	
Water. W91-10626	Decreased Norepinephrine and Epinephrine	BOPP, R. F.
Water. W91-10626 5F	Decreased Norepinephrine and Epinephrine Contents in Chromaffin Tissue of Rainbow	BOPP, R. F.
	Decreased Norepinephrine and Epinephrine Contents in Chromaffin Tissue of Rainbow Trout (Oncorhynchus mykiss) Exposed to	BOPP, R. F.
W91-10626 5F BEVEN, K. J.	Decreased Norepinephrine and Epinephrine Contents in Chromaffin Tissue of Rainbow Trout (Oncorhynchus mykiss) Exposed to Diethyldithiocarbamate and Amylxanthate.	BOPP, R. F.  Major Incident of Dioxin Contamination: Sediments of New Jersey Estuaries.
W91-10626 5F  BEVEN, K. J.  Throughflow and Solute Transport in an Isolat-	Decreased Norepinephrine and Epinephrine Contents in Chromaffin Tissue of Rainbow Trout (Oncorhynchus mykiss) Exposed to	BOPP, R. F.  Major Incident of Dioxin Contamination: Sediments of New Jersey Estuaries.
W91-10626 5F  BEVEN, K. J.  Throughflow and Solute Transport in an Isolated Sloping Soil Block in a Forested Catchment.	Decreased Norepinephrine and Epinephrine Contents in Chromaffin Tissue of Rainbow Trout (Oncorhynchus mykiss) Exposed to Diethyldithiocarbamate and Amylxanthate.  W91-10901  5C	BOPP, R. F.  Major Incident of Dioxin Contamination: Sediments of New Jersey Estuaries.
W91-10626 5F  BEVEN, K. J.  Throughflow and Solute Transport in an Isolat-	Decreased Norepinephrine and Epinephrine Contents in Chromaffin Tissue of Rainbow Trout (Oncorhynchus mykiss) Exposed to Diethyldithiocarbamate and Amylxanthate.  W91-10901 5C  BOARDMAN, G. D.	BOPP, R. F.  Major Incident of Dioxin Contamination: Sedi ments of New Jersey Estuaries.  W91-11341  5H  BOREN, H.
W91-10626 5F  BEVEN, K. J.  Throughflow and Solute Transport in an Isolated Sloping Soil Block in a Forested Catchment.	Decreased Norepinephrine and Contents in Chromaffin Tissue of Rainbow Trout (Oncorhynchus mykiss) Exposed to Diethyldithiocarbamate and Amylxanthate.  W91-10901 5C  BOARDMAN, G. D. Aquifer Restoration: Which Method.	BOPP, R. F.  Major Incident of Dioxin Contamination: Sedi ments of New Jersey Estuaries.  W91-11341  5E  BOREN, H.  Formation of Chlorophenols and Related Com
W91-10626 5F BEVEN, K. J. Throughflow and Solute Transport in an Isolated Sloping Soil Block in a Forested Catchment. W91-10993 2G	Decreased Norepinephrine and Epinephrine Contents in Chromaffin Tissue of Rainbow Trout (Oncorhynchus mykiss) Exposed to Diethyldithiocarbamate and Amylxanthate.  W91-10901 5C  BOARDMAN, G. D.	BOPP, R. F.  Major Incident of Dioxin Contamination: Sedi ments of New Jersey Estuaries.  W91-11341  BOREN, H.  Formation of Chlorophenols and Related Com pounds In Natural and Technical Chlorination
W91-10626 5F  BEVEN, K. J.  Throughflow and Solute Transport in an Isolated Sloping Soil Block in a Forested Catchment. W91-10993 2G  BIEDERMAN, L. A.  Direct Aqueous Injection-Liquid Chromatogra-	Decreased Norepinephrine and Contents in Chromaffin Tissue of Rainbow Trout (Oncorhynchus mykiss) Exposed to Diethyldithiocarbamate and Amylxanthate.  W91-10901 5C  BOARDMAN, G. D. Aquifer Restoration: Which Method.  W91-10486 5G	BOPP, R. F.  Major Incident of Dioxin Contamination: Sedi ments of New Jersey Estuaries.  W91-11341  5B  BOREN, H.  Formation of Chlorophenols and Related Compounds In Natural and Technical Chlorination Processes.
W91-10626 5F  BEVEN, K. J.  Throughflow and Solute Transport in an Isolated Sloping Soil Block in a Forested Catchment. W91-10993 2G  BIEDERMAN, L. A.  Direct Aqueous Injection-Liquid Chromatography With Post-Column Derivatization for De-	Decreased Norepinephrine and Contents in Chromaffin Tissue of Rainbow Trout (Oncorhynchus mykiss) Exposed to Diethyldithiocarbamate and Amylxanthate. W91-10901 5C  BOARDMAN, G. D. Aquifer Restoration: Which Method. W91-10486 5G  BODO, B. A.	BOPP, R. F.  Major Incident of Dioxin Contamination: Sedi ments of New Jersey Estuaries.  W91-11341  5B  BOREN, H.  Formation of Chlorophenols and Related Compounds In Natural and Technical Chlorination Processes.
W91-10626  BEVEN, K. J. Throughflow and Solute Transport in an Isolated Sloping Soil Block in a Forested Catchment. W91-10993  CG  BIEDERMAN, L. A. Direct Aqueous Injection-Liquid Chromatography With Post-Column Derivatization for Determination of N-Methylcarbamoyloximes and	Decreased Norepinephrine and Epinephrine Contents in Chromaffin Tissue of Rainbow Trout (Oncorhynchus mykiss) Exposed to Diethyldithiocarbamate and Amylxanthate. W91-10901 5C  BOARDMAN, G. D. Aquifer Restoration: Which Method. W91-10486 5G  BODO, B. A. Statistical Characterization of Atrazine Residues	BOPP, R. F.  Major Incident of Dioxin Contamination: Sedi ments of New Jersey Estuaries.  W91-11341  5E  BOREN, H.  Formation of Chlorophenols and Related Compounds In Natural and Technical Chlorination Processes.  W91-11508  5E
W91-10626 5F  BEVEN, K. J.  Throughflow and Solute Transport in an Isolated Sloping Soil Block in a Forested Catchment. W91-10993 2G  BIEDERMAN, L. A.  Direct Aqueous Injection-Liquid Chromatography With Post-Column Derivatization for De-	Decreased Norepinephrine and Contents in Chromaffin Tissue of Rainbow Trout (Oncorhynchus mykiss) Exposed to Diethyldithiocarbamate and Amylxanthate. W91-10901 5C  BOARDMAN, G. D. Aquifer Restoration: Which Method. W91-10486 5G  BODO, B. A.	BOPP, R. F.  Major Incident of Dioxin Contamination: Sedi ments of New Jersey Estuaries.  W91-11341  5B  BOREN, H.  Formation of Chlorophenols and Related Compounds In Natural and Technical Chlorination Processes.

BORICH, P. J. Soil Conservation Service and Extension: Cooperating to Enhance Services (MES Portion). W91-11170 6E	BOWEN, R. B. Pre-hydrolyzed Aluminum Hydroxide and Iron Hydroxide in Activated Sludge Treatment. W91-11539 5D	Einiger Stehender Gewasser bei Concepcion (Paraguay)). W91-11523 2H
BORSOS, B. Socio-Political Aspects of the Bos-Nagymaros Barrage System.	BOWMER, K.  New Standards for the Determination of Geosmin and Methylisoborneol in Water by Gas	BRISEID, T. Biotechnology Degradation and Mitigation of Offshore Oil Spills, Phase 1. Main Report: Tech-
W91-11217 6G	Chromatography/Mass Spectroscopy. W91-11329 5A	nology to Enhance Biodegradation of Oil Spills State of the Art and Perspectives for Technolo- gy Development.
BOSCH, A.  Concentration of Hepatitis A Virus in Environmental Samples.	BRADBURY, K. R. Tritium as an Indicator of Ground-Water Age in	W91-10735 5G
W91-10658 5A	Central Wisconsin. W91-10958 2F	BROCK, D. O. Dallas' Flood Caverns.
BOSSERT, W. A.  Northwest Kansas Groundwater Management District No. 4. An Abandoned Well Program.	BRADLEY, N. E.	W91-10493 8A
W91-11188 5G	Surface Dilution of Round Submerged Buoyant Jets. W91-10986 5E	BROWN, M. A.  Determination of Chlorinated Phenoxy Acid and Ester Herbicides in Soil and Water by
BOTELLA, M. S. Enumeration of Motile Aeromonas in Valencia Coastal Waters by Membrane Filtration.	BRAESTER, C. Denitrification in Laboratory Sand Columns:	Liquid Chromatography Particle Beam Mass Spectrometry and Ultraviolet Absorption Spec-
W91-10636 5B BOTTGER, K.	Carbon Regime, Gas Accumulation and Hy- draulic Properties.	trophotometry. W91-10893 5A
Fish Fauna of Various Bodies of Stagnant Water Near Concepcion (Paraguay) (Zur Fischfauna Einiger Stehender Gewasser bei Concepcion	BRAHMAM, N. K.	BROWN, S. R. Simulation of Bioecological and Water Quality Processes in Enclosed Coastal Seas.
(Paraguay)). W91-11523 2H	Seismic Hazard at Narmada Sagar Dam. W91-10949 8E	W91-10557 5C
BOTZENHART, K. Behaviour of Pathogenic Bacteria, Phages and Viruses in Groundwater During Transport and	BRANSKI, J. M.  Mathematical Modelling for Reservoir Water- Quality Management Through Hydraulic Struc- tures: A Case Study.	BRUCE, A. M. Production, Treatment and Handling of Sewage Sludge. W91-11116 5D
Adsorption. W91-10672 5B	W91-10490 5G	BRUNEAU, L.
Detection of Poliovirus in Water by Direct Iso- lation of the RNA and Hybridization with Gene	BRAUCH, H. J.  Strategy for Pesticide Control in Ground Water and Drinking Water.	Conductivity for Nutrient Control In CTMP Wastewater Treatment. W91-11495 5D
Probes. W91-10666 5A	W91-11312 5A	BRUNETTI, R.
Difficulty of Using Coliphages as 'Indicators' and 'Index' Organisms. W91-10661 5A	BRAUNBECK, T. Induction of Biotransformation in the Liver of Eel (Anguilla anguilla L.) by Sublethal Exposure to Dinitro-o-cresol: An Ultrastructural and Bio-	Effects of Linear Alkylbenzene Sulphonate (LAS) on Skeletal Development of Sea Urchin Embryos (Paracentrotus lividus LMK).  W91-10891  5C
Field Experiments with Microbiological Tracers in a Pore Aquifer. W91-10673 5B	chemical Study. W91-10826 5C	BRUNNER, P. H.
Transport of Microorganisms in the Underground: Processes, Experiments and Simulation	BREITTMAYER, V. A.  Protective Effect of Glycine Betaine on Survival of Escherichia coli Cells in Marine Environ-	Accumulation of Refractory 4-Nonylphenol During Mesophilic Anaerobic Sludge Stabiliza- tion. W91-10707 5D
Models. W91-10674 5B	ments. W91-10637 5B	Pathway Analysis of Selected Organic Chemi-
BOUDREAU, B. P. Reactive Continuum Representation of Organic Matter Diagenesis.	BRESCH, H.  Effect of 3,4-Dichloroaniline on the Early Life Stages of the Zebrafish (Brachydanio rerio): Re- sults of a Comparative Laboratory Study.	cals from Sewage to Agricultural Soil. W91-11123 5B BRUSSEAU, M. L.
W91-11448 2J BOURBIGOT, M. M.	W91-10828 5A	Application of a Multiprocess Nonequilibrium Sorption Model to Solute Transport in a Strati-
Efficiency of an Ozoflotation-Filtration Process for the Treatment of the River Thames at Walton Works.	BRESSAN, M. Effects of Linear Alkylbenzene Sulphonate (LAS) on Skeletal Development of Sea Urchin	fied Porous Medium. W91-11239 5B
W91-11268 5F BOURODIMOS, E. L.	Embryos (Paracentrotus lividus LMK). W91-10891 5C	BRYANT, C. W. Biological Dehalogenation of Kraft Mill
Oil Transport Management and Marine Pollu- tion Control: Oil Spill Prevention. W91-11081 5G	BRETTON, H.  Comprehensive Water Management Strategy: Credit River Watershed.	Wastewaters. W91-11497 5D
BOUSSAID, A.	W91-11043 6A	BRYANT, L. M. Predicting Concrete Service Life in Cases of
Aeromonas Species Stabilization Ponds in the Arid Region of Marrakesh, Morocco, and Rela- tion to Fecal-Pollution and Climatic Factors.	BRIDLE, T. R. Sludge Management by Thermal Conversion to Fuels.	Deterioration Due to Freezing and Thawing W91-10734 8F
W91-10842 5D  Dynamics of Non-01 Vibrio cholerae in Experi-	W91-10706 5D BRINGI, V. N.	BUCHANAN, M. V.  Direct Sampling Ion Trap Mass Spectrometry for the Rapid Determination of Volatile Organ
mental Sewage Stabilization Ponds Under Arid Mediterranean Climate.	Multiparameter Radar Estimation of Raindrop Size Distribution. W91-11097 7B	ics in Environmental Matrices. W91-11555 5A
W91-10690 5D  BOUTEN, W.	Squall Line in Southern Germany: Kinematics	BUCHBERGER, S. G. Modeling Lake Erie as a Stochastic Linear Res
Microwave Transmission, a New Tool in Forest Hydrological Research. W91-10995 2I	vanced Polarimetric and Doppler Radar Measurements.	ervoir. W91-11029 70
BOWDEN, A. V.	W91-11420 2B	BUCHER, J.
Production, Treatment and Handling of Sewage Sludge. W91-11116 5D	Fish Fauna of Various Bodies of Stagnant Water	Experience with Low-Head HydroPlant Fre quency Control. W91-11214

8C

BUCHKO, M. Investigation of Local Scour in Cohesionless Sediments Using a Tunnel-Model.	Oxygen Uptake in an intertidal Sandflat and an Intertidal Mudflat. W91-10865 2L	CARTER, T. R. Climatic Change and Future Agroclimatic Potential in Europe.
W91-10746 2J	CAMPANELLA, R. G.	W91-10970 2B
BUCKLAND, S. J. Identification of Dioxin Sources In an Integrated Wood Processing Facility. W91-11475 5B	Comparison of Field Consolidation with Laboratory and In Situ Tests.  W91-10781 8D	CARVOUNIS, C. C. Oil Transport Management and Marine Pollution Control: Oil Spill Prevention.
W31-114/3	CAMPBELL, G.	W91-11081 5G
BUDHU, M. Permeability of Soils with Organic Fluids. W91-10783 5B	Permeability of Soils with Organic Fluids. W91-10783 5B	CASANOVA, J. Correlated Oceanic and Continental Records
BUISMAN, C. J. N. Biotechnological Sulphide Removal from Effuents.	CAMPBELL, H. W. Sludge Management by Thermal Conversion to Fuels.	Demonstrate Past Climate and Hydrology of North Africa (0-140 ka). W91-10788 2B
W91-11502 5D	W91-10706 5D	CASEMORE, D. P.
BUNCK, C. M. Subchronic Hepatotoxicity of Selenomethionine Ingestion in Mallard Ducks.	Status Report on Environment Canada's Oil From Sludge Technology. W91-11133 5D	Epidemiology of Human Cryptosporidiosis and the Water Route of Infection. W91-10643 5B
W91-10838 5C	CAMPIN, D. N.	CASPER, S. J.
BURHEM, J. E. Treatment of Bleach-Plant Effluents with Membrane Filtration and Sorption Techniques.	Identification of Dioxin Sources In an Integrated Wood Processing Facility. W91-11475 5B	Diatom Analysis, Late-Glacial and Post-Glacial Development of Lake Kleiner Barsch-See (GDR)A Preliminary Note.
W91-11489 5D		W91-11517 2H
BURKART, M. R.	Treatability of Bleached Kraft Pulp and Paper Mill Wastewaters In a New Zealand Aerated	CASPERS, N.
Planned Studies of Agrichemicals in Ground and Surface Water in the Mid-Continental United States.	Lagoon Treatment System. W91-11499 5D	Effect of 3,4-Dichloroaniline on the Early Life Stages of the Zebrafish (Brachydanio rerio): Re- sults of a Comparative Laboratory Study.
W91-11168 5B	CANARUTTO, S.	W91-10828 5A
BURN, D. H.	Heavy Metal Speciation in Sewage Sludge Fol- lowing a Phyto-Dewatering Treatment.	CASSON, L. W.
Risk-based Performance Criteria for Real-time Reservoir Operation.	W91-11147 5D	Determining Giardiasis Prevalence by Examina- tion of Sewage.
W91-11275 4A	CANDINAS, T.  Ban on Phosphorus in Detergents: The Effects	W91-10646 5A
BURNS, D. G. Coordinating Roles and Services: Soil Conserva- tion Service and Extension Service.	on the Phosphorus Contents of Swiss Sewage Sludges and on the Efficiency of Phosphorus Elimination by Sewage Treatment Plants.	Distribution of Giardia Cysts in Wastewater. W91-10649 5B
W91-11171 6E	W91-11142 5D	CASWELL, B.
BUSER, D. J.	CANFIELD, D. E.	Municipal Ground Water from Ancient Crystal- line Bedrock.
Polychlorinated Biphenyls in Dated Sediment Cores from Green Bay and Lake Michigan. W91-10979 5B	Macrophyte Standing Crop and Primary Pro- ductivity in Some Florida Spring-Runs.	W91-10822 2F
BUTLER, R. C.	W91-10812 2E	CAULFIELD, H. P. Future Water Management Problems: The Fed-
Deep-Seated Consolidation Settlements in the Fraser River Delta.	CANTON, J. H. Ecotoxicological Effects Assessment: A Com-	eral Role In Their Solution. W91-11210 4A
W91-10948 8D	parison of Several Extrapolation Procedures. W91-10830 5A	CERVENY, R. S.
BUTLER, T. J.  Impact of Changing Regional Emissions on Pre-	CARA, C. A.	Tree-Ring Reconstructed Sunshine Duration over Central USA.
cipitation Chemistry in the Eastern United States.	Quantitative Determination of Acrylonitrile in an Industrial Effluent by Ambient-Temperature	W91-10972 2I
W91-10473 5G	Purge and Trap Capillary GC-MS and by	CHAI, A.  Rise and Fall of the Potomac River Striped Bass
BUTTLE, J. M. Comparison of Measured and Estimated Unsatu-	Heated Purge and Trap GC-FID. W91-11336 5A	Stock: A Hypothesis of the Role of Sewage. W91-11529 5C
rated Hydraulic Conductivities During Snow-	CARBIENER, R.	CHALOT, F.
melt. W91-10904 2G	Rhine Rift Valley Groundwater-River Interac- tions: Evolution of their Susceptibility to Pollu- tion.	Sludge Recycling in Agriculture Compared with Other Disposal Methods in France.
BYRON, E. R. Increased Precipitation Acidity in the Central	W91-10849 5B	W91-11137 5E
Sierra Nevada. W91-10471 5B	CAREY, W. P. Dendrogeomorphic Approach to Estimating	CHAMBERS, L. W. Method for Installing Miniature Multilevel Sam-
Potential Effects of Global Warming on the Primary Productivity of a Subalpine Lake.	Slope Retreat, Maxey Flats, Kentucky. W91-11395 2D	pling Wells. W91-10962 5A
W91-10819 2H	CARLIER, P.	CHAN, D. H.
BZIK, T. J.  Quantitative Determination of Acrylonitrile in	Major Ions in Marine Rainwater With Attention to Sources of Alkaline and Acidic Species. W91-11250 5B	Finite-Element Analysis of Softening Effects in Fissured, Overconsolidated Clays and Mudstones.
an Industrial Effluent by Ambient-Temperature Purge and Trap Capillary GC-MS and by		W91-10776 8D
Heated Purge and Trap GC-FID. W91-11336 5A	CARRERAS, P. E. Mathematical Simulation of Pollutant Disper-	CHANDRAKANTH, M. G.
	sion. W91-10488 5B	Groundwater Depletion in India: Institutional Management Regimes.
CAHOON, L. B. Natural Phosphate Source for Lake Waccamaw,		W91-11382 4B
North Carolina, USA.	CARRINGTON, E. G. Destruction of Faecal Bacteria, Enteroviruses	CHANDRAKANTHA, G.
W91-11405 2H CAMMEN, L. M.	and Ova of Parasites in Wastewater Sludge by Aerobic Thermophilic and Anaerobic Mesophi-	Studies on Assessment of Water Balance and Its Quality in Gurpur River Basin, Karnataka State,
Annual Bacterial Production in Relation to	lic Digestion.	India.
Benthic Microalgal Production and Sediment	W91-10688 5D	W91-11065 5B

CHANDRASEKAR, V. Multiparameter Radar Estimation of Raindrop Size Distribution.	Method for Assessing Residual NAPL Based on Organic Chemical Concentrations in Soil Sam- ples.	CHURCH, T. M. Sulfur Enrichment of Humic Substances in a Delaware Salt Marsh Sediment Core.
W91-11097 7B	W91-10797 5A	W91-11258 2L
CHANG, A. T. C. Satellite-Derived Reflectance of Snow-Covered Surfaces in Northern Minnesota. W91-11353 7C	CHEVOLOT, L. Studies of Dissolved Carbohydrates (or Carbo- hydrate-Like Substances) in an Estuarine Envi- ronment.	CLAMEN, M. Fluctuating Great Lakes Water Levels: Progress and Opportunities.
CHANG, C. C.	W91-10840 2L	W91-11032 6A
Impact of Recharge Through Residual Oil Upon Sampling of Underlying Ground Water. W91-10793 5B	CHIARIZIA, R. Application of Supported Liquid Membranes for Removal of Uranium From Groundwater.	CLARE, R. W. Simazine Concentrations in a Stream Draining an Agricultural Catchment.
CHANG, L. L. Aqueous Photolysis of Napropamide. W91-11376 5B	W91-11370 5G CHO, C. H.	W91-11364 4C CLARK, C.
CHANGNON, S. A.	Mariculture and Eutrophication in Jinhae Bay, Korea.	Four-Parameter Model for the Estimation of Rainfall Frequency in South-West England.
Precipitation Changes in Fall, Winter, and Spring Caused by St Louis.	W91-10558 5B CHOU, H. T.	W91-11415 2B
W91-10500 2B	Fluidization of Marine Mud by Waves.	CLARK, S.
CHARRIERE, C. Miniaturized Fluorogenic Assays for Enumera-	W91-10533 5B CHOUBEY, V. D.	Fertility of Workers Chronically Exposed to Chemically Contaminated Sewer Wastes.
tion of E. coli and Enterococci in Marine Water. W91-10639 5A	Geotechnical Appraisal of the Foundation Rock Mass Behaviour of Narmada Sagar Dam	W91-11316 5D
CHASHCHINA, N. I. Sorption Properties and Moisture Hysteresis of	Project, Central India: A Case Study. W91-10784 8E	CLARK, S. D. Tensions Between Water Legislation and Cus- tomary Rights.
Soils. W91-10916 2G	CHOUBEY, V. K.	W91-11383 6E
	Nature of Suspended Solids and IRS1A-LISSI	CLARK, T. A.
CHAUDHARI, S. Geotechnical Appraisal of the Foundation Rock Mass Behaviour of Narmada Sagar Dam Project, Central India: A Case Study.	Data: A Case Study of Tawa Reservoir (Nar- mada Basin). W91-11221 5G	Effects of Chlorination Conditions On the AOX and Chlorinated Phenol Content of Kraft Bleach Plant Wastewaters.
W91-10784 8E	CHOUDHURY, B. J. Multispectral Satellite Data in the Context of	W91-11474 5D
CHAUSSOD, R. Microbial Biomass and Biological Activities in	Land Surface Heat Balance. W91-11428 7B	CLARKE, J. S. Geohydrologic Evaluation of Spring Sites at
an Acid Sandy Soil Treated with Sewage Sludge or Farmyard Manure in a Long Term Field	CHRISTENSEN, E. R. Polychlorinated Biphenyls in Dated Sediment	Social Circle, Georgia, December 5-8, 1988. W91-10767 2F
Experiment. W91-11160 5E	Cores from Green Bay and Lake Michigan. W91-10979 5B	CLASEN, J.
CHAVOOSHIAN, B. B. Buffer Strips to Protect Water Supply Reservoirs: A Model and Recommendations.	Recent Sedimentation in Lake Michigan. W91-10976 2J	Flocculation of Micro-organisms. W91-11267 5F
W91-10816 5G	CHRISTIAN, S. D.	CLAYTON, C. R. I.
CHAWLA, G. Ultrastructural and Biochemical Effects of Cad-	Use of Ligand-Modified Micellar-Enhanced Ul- trafiltration in the Selective Removal of Metal	Pressure of Clay Backfill against Retaining Structures. W91-10947 8D
mium on the Aquatic Fern Marsilea minuta Linn. W91-10829 5C	Ions from Water. W91-11318 5D	CLEAVELAND, M. K.
	CHRTEK, S.	Tree-Ring Reconstructed Sunshine Duration over Central USA.
CHEN, H.  Environmental Assessment of Wastewater Marine Disposal of Xiaogang Zone, Ningbo.	UV Disinfection of Secondary Effluents from Sewage Treatment Plants.	W91-10972 2I
W91-10570 SE	W91-10681 5D	CLITES, G. A.
CHEN, L. M. Polychlorinated Biphenyls in Dated Sediment	CHU, M. L. Study on Triple-Membrane-Separator (TMS)	Design of Economic and Efficient Treatment Station for Acidic Streams. W91-11077 5G
Cores from Green Bay and Lake Michigan.	Process to Treat Aqueous Effluents Containing Uranium.	
	W91-11367 5D	CLULOW, F. V. 226-Ra and Other Radionuclides in Water,
CHEN, X. L. Behavior of the Fungicide MBAMT in Water. W91-11315 5A	CHUANG, Y. Analysis of Large Scale Water Distribution Sys- tems.	Vegetation, and Tissues of Beavers (Castor cana- densis) from a Watershed Containing U Tailings
CHENG, K. M.	W91-10983 5F	Near Elliot Lake, Canada. W91-11454 5B
Dioxin Contamination and Growth and Development in Great Blue Heron Embryos.	CHUGAEVA, G. A. Characteristics of Mining Quarries on Hydrau-	COALE, K. H.
Ŵ91-10837 5C	lic-Fill Dumps.	Determination of Subnanomolar Levels of Iron(II) and Total Dissolved Iron in Seawater
CHERGUI, H.  Processing of Leaves of Trees and Aquatic Ma-	W91-11286 8A	by Flow Injection Analysis with Chemilumines-
crophytes in the Network of the River Rhone. W91-11402 2H	CHUHAN, Z. Seismic Fracture Analysis of Concrete Gravity	cence Detection. W91-10773 2K
CHERNOBEREZHSKY, Y. M.	Dams. W91-10787 8F	COCHRAN, B. G.
Thermocatalytic and Chemical Treatment of Lignin-Aluminium Sludge and Utilization of the	CHUNG, S. Y.	Aquatic Macroinvertebrates of the St. Francis Sunken Lands in Northeast Arkansas.
Resulting Adsorbent-Coagulant. W91-11503 5D	Development of an Enzyme-Linked Immunosor- bent Assay for Geosmin.	W91-10844 4C
CHERRY, J. A.	W91-10921 5F	COCHRANE, B. J.
Depth of Fractures and Active Ground-Water	CHURCH, M.	Effects of Copper and Tributyltin on Stress Pro- tein Abundance in the Rotifer Brachionus plica-
Flow in a Clayey Till Plain in Southwestern Ontario.	Distance of Movement of Coarse Particles in Gravel Bed Streams.	tilis.
W91-10959 2F	W91-11231 2J	W91-10900 5C

CODINA, J. C.	CONWAY, J. P. New York City's Delaware River Basin	(AMPA) in Environmental Water: Collaborative
Relationship Between Pseudomonas aeruginosa and Bacterial Indicators in Polluted Natural	Supply-A Case Study in Interstate Coopera-	Study. W91-11261 5A
Waters.	tion	
W91-10635 5A	W91-11046 6E	COWGILL, U. M.
COHEN, M. K.	COOK, K. A.	Acid Precipitation: A Review. W91-11074 5B
Mechanisms of Resistance to Polychlorinated	FACTA 1990 Conservation and Environmental Highlights.	W31-110/4
Biphenyls (PCB) in Two Species of Marine Dia- toms.	W91-10507 5G	COWIE, B. A.
W91-11562 5C	COOLEY, K. R.	Effect of Land Development on Groundwater
COHEN, W. L.	Self-Affine Scaling and Subsurface Response to	Recharge Determined from Non-Steady Chlo- ride Profiles.
FACTA 1990 Conservation and Environmental	Snowmelt in Steep Terrain.	W91-10991 4C
Highlights.	W91-10912 2G	
W91-10507 5G	COOMBS, R. M.	CRAIGG, S. D.  Hydrogeology of the Point Lookout Sandstone
COIMBRAO, C. A.	Use of Bacillus thuringiensis var. israelensis to Control the Nuisance Fly Sylvicola fenestralis	in the San Juan Structural Basin, New Mexico,
Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.	(Anisopodidae) in Sewage Filter Beds.	Colorado, Arizona, and Utah.
W91-10685 5D	W91-10890 5D	W91-11114 2F
	COOPER, C. M.	CRANE, T. R.
COKELET, E. D.  Remobilization of Cu from Marine Particulate	Relationship of MSS and TM Digital Data with	Cooperative Data on Regional Water Use: The
Organic Matter and from Sewage.	Suspended Sediments, Chlorophyll, and Tem- perature in Moon Lake, Mississippi.	Great Lakes Regional Water Use Data Reposi-
W91-10923 5B	W91-11354 7C	tory.
COLBOURNE, J.	COPPOLA, S.	W91-11010 6D
Thames Water's Experiences with Cryptospori-	Composting Raw Sewage Sludge in the Absence	Regional Approach to Drought Planning and
dium. W91-10617 5C	of Bulking Agents. W91-11149 5E	Management in the Great Lakes Basin.
W91-10617 5C		W91-11012 6A
COLBOURNE, J. S.	COREY, O.	CRANFORD, J. A.
Effect of Heat Shock on Recovery of Escheri- chia coli from Drinking Water.	Pesticides and Drinking Water Information: A Perspective from EPA's National Pesticide	Influence of Flooded Soil on Chemical Compo-
W91-10628 5F	Survey.	sition of Annual Ryegrass and Digestibility by Meadow Voles.
COVENI P	W91-11173 5D	W91-11536 2I
COLIN, F.  Application of Electrical Fields to Thicken and	CORMIER, M.	
Dewater Sewage Sludges.	Salmonella Detection in Sewage Waters Using	CRAUN, G. F.
W91-10700 5D	Fluorescent Antibodies. W91-10687 5D	Causes of Waterborne Outbreaks in the United States.
Physical and Chemical Characterization of	CORNETT, R. J.	W91-10616 5B
Sewage Sludge.	Streamflow Generation in a Headwater Basin on	CD ANDODD C D
W91-11117 5D	the Precambrian Shield.	CRAWFORD, C. B.  Comparison of Field Consolidation with Labora-
COLWELL, R. T.	W91-11349 2E	tory and In Situ Tests.
Direct Detection of Enteropathogenic Bacteria in Estuarine Water Using Nucleic Acid Probes.	CORTESI, P.	W91-10781 8D
W91-10664 5A	Seasonal Variations of Aliphatic Hydrocarbons in Sardina pilchardus (Walb.) (Teleostei: Clupei-	Deep-Seated Consolidation Settlements in the
CONDREN, A. J.	dae) Tissues.	Fraser River Delta.
Evaluation of Full Scale Activated Sludge Sys-	W91-10839 5B	W91-10948 8D
tems Utilizing Powdered Activated Carbon Ad-	COSPER, E. M.	CRAWFORD, C. G.
dition with Wet Air Regeneration. W91-11099 5D	Mechanisms of Resistance to Polychlorinated	Description of the Physical Environment and
W91-11099	Biphenyls (PCB) in Two Species of Marine Dia- toms.	Coal-Mining History of West-Central Indiana,
CONLEY, D. J.	W91-11562 5C	with Emphasis on Six Small Watersheds.
Size Structure of Particulate Biogenic Silica in Lake Michigan.	COTTON, W. R.	W91-11576 2E
W91-10975 2H	Effect of Decoupled Low-Level Flow on	CRIDDLE, C. S.
CONNEL, A. D.	Winter Orographic Clouds and Precipitation in the Yampa River Valley.	Electrolytic Model System for Reductive Deha-
Impact of Titanium Dioxide Waste on Fertiliza-	W91-11410 2B	logenation in Aqueous Environments. W91-11343 5B
tion in the Sea Urchin Echinometra mathaei.	COUBROUGH, P.	W91-11343 5B
W91-10870 5C	Occurrence of Male-Specific and Somatic Bac-	CROLEY, T. E.
CONNELL, D. B.	teriophages in Polluted South African Waters.	Great lakes Hydrological Impacts of 2xCO2 Cli-
Pathways of Silver Uptake and Trophic Trans-	W91-10662 5B	mate Change. W91-11061 5C
fer in Estuarine Organisms. W91-11337 5B	COULET, W.	
	Legal System and Management of Southern France Lagoons.	CROW, N. B.
CONSIGLIO, M.  Control of Enteric Micro-organisms by Aerobic-	W91-10611 5G	Remedial Investigation of the High Explosives Burn Pit Facility, Building 829 Complex, Law-
Thermophilic Co-Composting of Wastewater	COULTER, R. L.	rence Livermore National Laboratory Site 300.
Sludge and Agro-Industry Sludge.	Comparison of Nocturnal Drainage Flow in	W91-10731 5B
W91-10693 5E	Three Tributaries. W91-10501 2E	CROWTHER, J. M.
CONSTANT, C. K.		Effect of Dissolved Nutrients and Inorganic Sus-
Communicating with Farmers: Providing Useful and Reliable Sources of Information.	COURTNEY, C. C.	pended Solids on the Survival of E. coli in
W91-11164 5G	Review of Fisheries Habitat Improvement Projects in Warmwater Streams, with Recom-	Seawater.
	mendations for Wisconsin.	W91-10638 5B
CONTE, L. S.  Seasonal Variations of Aliphatic Hydrocarbons	W91-11591 2H	CRUTZEN, P. J.
in Sardina pilchardus (Walb.) (Teleostei: Clupei-	COWELL, J. E.	Zonal Average Cloud Characteristics for Global
dae) Tissues.	Liquid Chromatographic Determination of Gly-	Atmospheric Chemistry Modelling.
W91-10839 5B	phosate and Aminomethylphosphonic Acid	W91-10728 2B

CRYSTAL, R.	DAM, W. L.	DAVIS, W. G.
Wellhead Protection in Massachusetts: Protect- ing Public Water Supplies from Pesticide Im-	Hydrogeology of the Point Lookout Sandstone in the San Juan Structural Basin, New Mexico,	Melvin Price Locks and Dam Auxiliary Lock and Rotary Lock Culvert Valve, Mississippi
pacts. W91-11182 5G	Colorado, Arizona, and Utah. W91-11114 2F	River, Alton, Illinois: Hydraulic Model Investi-
		gation. W91-10723 8C
CUBITT, W. D.  Review of the Epidemiology and Diagnosis of	DAMBERG, R. C. Regional Approach to Drought Planning and	
Waterborne Viral Infections.	Management in the Great Lakes Basin.	DAVYDOVA, I. Y.  Causes of Degradation of Chemical and Physical
W91-10651 5B	W91-11012 6A	Properties of Chernozems Irrigated with Non-
CUINGIOGLU, E. Present State of Environmental Pollution in	DAMIANI, V.	mineralized Water.
Coastal Sea Area and Measures for Protection.	Trace Element Distribution in Surficial Sedi- ments of the Northern Tyrrhenian Sea: Contri-	W91-10913 2G
W91-10540 5B	bution to Heavy-Metal Pollution Assessment.	DAWDY, D. R.
CULBERSON, C. H.	W91-11444 5A	Interpretation of Hydrologic Effects of Climate Change in the Sacramento-San Joaquin River
Iodine Chemistry in the Water Column of the Chesapeake Bay: Evidence for Organic Iodine	DANCER, B. N.	Basin, California.
Forms. W91-10496 2L	Use of Bacillus thuringiensis var. israelensis to Control the Nuisance Fly Sylvicola fenestralis	W91-11552 5C
	(Anisopodidae) in Sewage Filter Beds.	DAWSON, D. A.
CULLINAN, V. I. Confirmatory Chemical Analyses and Solid	W91-10890 5D	Initial Evaluation of Developmental Malforma-
Phase Bioassays on Sediment from the Columbia	DANIEL, C. C.	tion as an End Point in Mixture Toxicity Hazard Assessment for Aquatic Vertebrates.
River Estuary at Tongue Point, Oregon. W91-10753 5B	Evaluation of Site-Selection Criteria, Well Design, Monitoring Techniques, and Cost Anal-	W91-10832 5C
CUMBERLAND, J. H.	ysis for a Ground-Water Supply in Piedmont	DE BEKKER, P. H. A. M. J.
Improved Policy Instruments for Management	Crystalline Rocks, North Carolina. W91-11596 2F	Wet Oxydation as the Alternative for Sewage
of Enclosed Coastal Seas and Estuaries: The		Sludge Treatment. W91-11146 5D
Chesapeake Bay, USA. W91-10610 2L	DANIELSON, L. E. ATLAS*GRAPHICS: An Affordable Mapping	W91-11146 5D
CURL, H. C.	System.	DE BIKUNA, B. G.
Remobilization of Cu from Marine Particulate	W91-11175 7C	Morphology and Quantitative Analysis of Fluvi- al Erosion Systems in the Hydrological Network
Organic Matter and from Sewage.	DASGUPTA, T. P.	of the Basque Country Autonomous Region.
W91-10923 5B	Dynamics of Pesticides in Tropical Conditions.	W91-11265 2J
CURRAN, J. C. Effect of Dissolved Nutrients and Inorganic Sus-	<ol> <li>Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta</li> </ol>	DE BLES, F.
pended Solids on the Survival of E. coli in	Endosulfan.	Ion Concentrations in Interstitial Water as Indi-
Seawater. W91-10638 5B	W91-11375 5B	cators for Phosphorus Release Processes and
	DATE, E.	Reactions. W91-10888 2K
CUSHMAN, J. H. Diffusion in Fractal Porous Media.	Eutrophication in Hiroshima Bay. W91-10536 5B	
W91-11243 2F		DE BRUIN, H. A. M. Virological Quality of Recreational Waters in
CUTHBERT, D.	DAUTA, A.  Comparative Study and Mathematical Modeling	the Netherlands.
1987-89 Drop in Great Lakes Water Levels,	of Temperature, Light and Growth of Three	W91-10653 5B
Causes and Effect. W91-11023 2H	Microalgae Potentially Useful for Wastewater Treatment.	DE GALEN, L.
CZARNECKI, J. B.	W91-10937 5D	Analysis of Halogenated Acetic Acids in Dutch
Hydrogeologic Inferences from Drillers' Logs	DAVE, N. K.	Drinking Water. W91-10938 5F
and from Gravity and Resistivity Surveys in the	226-Ra and Other Radionuclides in Water,	W91-10938 5F
Amargosa Desert, Southern Nevada. W91-10996 5E	Vegetation, and Tissues of Beavers (Castor cana-	DE HAAN, H.
Hydrologic, Meteorological, and Unsaturated-	densis) from a Watershed Containing U Tailings Near Elliot Lake, Canada.	Multicomponent Kinetic Analysis of Iron Speci- ation in Humic Lake Tjeukemeer: Comparison
Zone Moisture-Content Data, Franking Lake	W91-11454 5B	of Fulvic Acid from the Drainage Basin and
Playa, Inyo County, California. W91-11089 2F	DAVENPORT, R.	Lake Water Samples.
	Acute Phototoxicity of Harbor and Tributary	W91-11339 2H
D'YAKOV, Y. N. Hydraulicking in Environmental Protection and	Sediments from Lower Lake Michigan. W91-10977 5C	DE HAAN, W.
Restoration.		Deterministic Computer-Aided Optimum Design of Rock Rubble-Mound Breakwater
W91-11283 5G	DAVIDSON, R. A.  Melvin Price Locks and Dam Auxiliary Lock	Cross-Sections.
DA CUNHA, R. P.	and Rotary Lock Culvert Valve, Mississippi	W91-10785 8A
Analysis of a Sanitary-Embankment Failure Over the Rio de Janeiro Soft Clay Deposit.	River, Alton, Illinois: Hydraulic Model Investi-	DE JESUS, J. A. O.
W91-10780 8D	gation. W91-10723 8C	Mathematical Modelling for Reservoir Water-
DALE, V. H.	DAVIPS D H	Quality Management Through Hydraulic Struc-
Atmospheric Carbon Dioxide and the Global	DAVIES, D. H. Use of Bacillus thuringiensis var. israelensis to	tures: A Case Study. W91-10490 5G
Carbon Cycle: The Key Uncertainties. W91-11068 5B	Control the Nuisance Fly Sylvicola fenestralis	
DALENTOFT, E.	(Anisopodidae) in Sewage Filter Beds. W91-10890 5D	DE LA NOUE, J.  Comparative Study and Mathematical Modeling
Investigation of Anaerobic Removal and Degra-		of Temperature, Light and Growth of Three
dation of Organic Chlorine from Kraft Bleach-	DAVIES, T. D. Sequential Sampling of Particles, Major Ions and	Microalgae Potentially Useful for Wastewater
ing Wastewaters. W91-11492 5D	Total Trace Metals in Wet Deposition.	Treatment. W91-10937 5D
DALLIMORE, S. R.	W91-11249 5B	
Engineering Geology of Nearshore Areas off	DAVIS, R. E.	DE LEER, E. W. B.  Analysis of Halogenated Acetic Acids in Dutch
Richards Island, N.W.T.: A Comparison of	Hydrology of the Arbuckle Mountains Area, South-Central Oklahoma.	Drinking Water.
Stable and Actively Eroding Coastlines. W91-10944 2J		W91-10938 5F

DE LEON, R. Detection of Rotay	viruses in Water by Gene	DELOREY, D. E. Case Studies in Data Analysis.	DICKSON, P.  Case Studies in Data Analysis.
Probes. W91-10668	5A	W91-10733 2B	W91-10733 2B
M 31-10009	JA.	DEMEL, I.	
DE NIET, J.		Closing Paper Mill Whitewater Circuits by In-	DIERBERG, F. E.
	Electrodialysis Reversal for	serting an Anaerobic Stage with Subsequent	Non-Point Source Loadings of Nutrients and
	Surface Water to Make-Up	Treatment.	Dissolved Organic Carbon from an Agricultural- Suburban Watershed in East Central Florida.
Water. W91-11368	5F	W91-11477 5G	W91-10927 5B
		DEMPSEY, B. A.	
	aste Water From Wet	Agronomic Effects of Land Application of	DIERICKS, W.
With Aid of Crossflo	Gas Desulfurization Plants	Water Treatment Sludges. W91-11459 4C	Roughness Coefficients of Watercourse Revet-
W91-11371	5D		ted With Half-Circular Concrete Pipes. Results of Field Measurements in Watercourse S 333 at
DE ROO, A. P. J.		DENISOVA, A. I.	Maarkedal.
	racer in an Erosion Study in	Effect of Hydroelectric Stations on Water Qual- ity and Development of Phytoplankton in the	W91-11431 8B
South Limburg (The	e Netherlands) and the Influ-	Lower Pools of Reservoirs.	DIEZ, J. M.
ence of Chernobyl F	fallout. 7B	W91-11289 6G	Concentration of Hepatitis A Virus in Environ-
W91-11351	78	DENNIS, P. J.	mental Samples.
DE VEGT, A. L.		Thames Water's Experiences with Cryptospori-	W91-10658 5A
	ent of Bleached TMP and the BioPAQ UASB System.	dium. W91-10617 5C	DIK, P. E.
W91-11501	5D	W91-10617 5C	Modelling Water and Solute Transport in Ma-
DE VICENTE, A.		DENNISON, D. I.	croporous Soil. I. Model Description and Sensi-
	en Pseudomonas aeruginosa	Status Report on Remedial Investigation of the 300 Area Process Ponds.	tivity Analysis.
	cators in Polluted Natural	W91-11583 5G	W91-10803 5B
Waters. W91-10635	5A	DENTON, R. A.	Modelling Water and Solute Transport in Ma-
	34	Seasonal Influences on the Sediment Transport	croporous Soil. II. Chloride Breakthrough
DE VILLIERS, J. C.	hods for the Microbiological	Characteristics of the Sacramento River, Cali-	Under Non-Steady Flow. W91-10804 2G
Analysis of Shellfish		fornia.	W91-10804 2G
W91-10695	5A	W91-10847 2J	DILLIS, M. P.
DE WATER, E.		DESMONTS, C.	Road Salting Impacts in Massachusetts.
	ission, a New Tool in Forest	Salmonella Detection in Sewage Waters Using Fluorescent Antibodies.	W91-11053 4C
Hydrological Resea W91-10995	rch.	W91-10687 5D	DILLON, T. M.
		DEVEREL, S. J.	Application of a Hazard Assessment Research
DE WET, C. M. E. Evaluation of Fecal	Enterococci Isolation Media	Ground-Water Flow and Solute Movement to	Strategy to the Ocean Disposal of a Dredged Material: Overview.
	Pollution in Chlorinated	Drain Laterals, Western San Joaquin Valley,	W91-10740 5E
Water.	-	California. I. Geochemical Assessment. W91-10768 5B	
W91-10626	5F		DINAR, A.  Production Functions Relating Crop Yield,
DEAL, J.		Ground-Water Flow and Solute Movement to	Water Quality and Quantity, Soil Salintiy and
	he Relationship Between the the Amounts of Nitrogenous	Drain Laterals, Western San Joaquin Valley, California. II. Quantitative Hydrologic Assess-	Drainage Volume.
	d Study on the Lee River.	ment.	W91-11434 3C
W91-10940	5C	W91-10769 5B	DINICOLA, R. S.
DEANGELIS, D. L.		DEVI, S.	Characterization and Simulation of Rainfall-
	on Dioxide and the Global	Ultrastructural and Biochemical Effects of Cad-	Runoff Relations for Headwater Basins in West-
Carbon Cycle: The W91-11068	Key Uncertainties. 5B	mium on the Aquatic Fern Marsilea minuta Linn.	ern King and Snohomish Counties, Washington. W91-11592 2A
		W91-10829 5C	W 91-11392
DEASON, J. P. Management of	Irrigation-Induced Contami-	DEY, S. C.	DIRUGGIERO, J.
nants.		Impact of Physico-chemical Complexes on	Direct Detection of Enteropathogenic Bacteria
W91-11063	5G	Plankton Density in Dhir Beel of Assam.	in Estuarine Water Using Nucleic Acid Probes. W91-10664 5A
DEDEK, W.		W91-11527 2H	
	f Hydrophilic and Hydropho- Aqueous Solutions and Ex-	DIAL, D. C.	DISARO, S. T. Seasonal Variation of Biomass and Production
	es Using the Polymeric Sor-	Maps of the '400-foot,' '600-foot,' and Adjacent Aquifers and Confining Beds, Baton Rouge	Dynamics for Above and Belowground Compo-
bent Wofatit Y 77.		Area, Louisiana.	nents of a Spartina alterniflora Marsh in the
W91-11305	5A	W91-11086 2F	
DEENY, K. J.		DIAZ, J. M. B.	W91-10495 2L
	Scale Activated Sludge Sys-	'Parque de Donana', and Its Contribution to	DIXON, K. L.
dition with Wet Ai	vdered Activated Carbon Ad-	Environmental Activities for Environmental	Evaluating Aeration Technology for Radon Re-
W91-11099	5D	Protection. W91-10586 5G	moval. W91-11462 5F
DELATTRE, J. M.			W91-11462 5F
Interrelations Betw	veen Amoebae and Bacteria in	DICKERMAN, D. C. Hydrogeology, Water Quality, and Ground-	DMITRIEVA, I. L.
the Moselle River, W91-10650	France. 5B	Water Development Alternatives in the Lower	the Environment of the Altei Mountains in Con-
		Wood River Ground-Water Reservoir, Rhode	nection with Ecological Substantiation of the
	rogenic Assays for Enumera- Enterococci in Marine Water.	Island. W91-11572 2F	Katun Hydroelectric Station Project.
W91-10639	5A		W91-11292 5B
DELAUZANNE, R.		DICKSON, E. J. Economic Assessment of the Water Quality Ben-	DOBBS, R. A.
	gricultural Use of Residual	efits of Conservation Tillage on Southwestern	Fate and Effects of Semivolatile Organic Pollut-
Sludge.	-	Ontario Cropland.	ants During Anaerobic Digestion of Sludge.
W91-11139	5D	W91-11050 3F	W91-10884 5D

Morphology and Quantitative Analysis of Fluvi- al Erosion Systems in the Hydrological Network of the Basque Country Autonomous Region.	DUBROU, S.  Detection of Hepatitis A Virus and Other Enter- oviruses in Wastewater and Surface Water Sam- ples by Gene Probe Assay.	tion of Nitrogen-and Phosphorus-Containing Pesticides in Finiahed Drinking Waters: Collabo- rative Study. W91-11259 5A
W91-11265 2J	W91-10665 5A	W 71-11237
DOI, T.  Ecological Modelling at Osaka Bay Related to Long-Term Eutrophication.	DUCOMMUN, A. Use of Sewage Sludge on Agricultural Land: Impact on Soil Fauna.	Direct Aqueous Injection-Liquid Chromatogra- phy With Post-Column Derivatization for De- termination of N-Methylcarbamoyloximes and
W91-10556 5C	W91-11150 5E	N-Methylcarbamates in Finished Drinking Water: Collaborative Study.
DOLAN, D. M.	DUFFY, C. J.	W91-11260 5A
Great Lakes Total Phosphorus Model: Post	Self-Affine Scaling and Subsurface Response to	EDITORON T
Audit and Regionalized Sensitivity Analysis. W91-10974 2H	Snowmelt in Steep Terrain. W91-10912 2G	EDMUNDSON, J. A. Secchi Disk and Photometer Estimates of Light
DONAHUE, M. J.	DUMARS, C. T.	Regimes in Alaskan Lakes: Effects of Yellow
Institutional Morass: Constraints and Opportuni-	Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes	Color and Turbidity. W91-10860 2H
ties for Issue Management. W91-11036 6A	and Failures.	EDWARDES, M.
Desired Assessab to Desught Blancing and	W91-11008 6E	Prospective Epidemiological Study of Drinking
Regional Approach to Drought Planning and Management in the Great Lakes Basin.	DUPONT, D. P. Evaluating the Impact of Water Quality Upon	Water Related Gastrointestinal Illnesses.
W91-11012 6A	the Value of Recreational Fishing.	W91-10618 5B
DONALDSON, A. M.	W91-11058 6G	EDWARDS, G. S.
Environmental Control Impacts of Selected Al- ternate Fuels on Existing Power Plants.	DUPRAS, E. F. Studies on the Environmental Persistence of S-	Ozone, Acidic Precipitation, and Soil Mg Ef- fects on Growth and Nutrition of Loblolly Pine
W91-11078 5G	31183 (Pyriproxyfen): Adsorption onto Organic	Seedlings.
DONARD, O. F. X.	Matter and Potential for Leaching through Soil. W91-10831 5B	W91-10918 5C
Organotin Stability During Storage of Marine	W91-10831 3B	EDWARDS, N. T.
Waters and Sediments. W91-11255 5A	DUTKA, B. J.  Coliphage and Bacteriophage as Indicators of	Ozone, Acidic Precipitation, and Soil Mg Ef-
	Recreational Water Quality.	fects on Growth and Nutrition of Loblolly Pine Seedlings.
DONG, H. Simultaneous Ultraviolet Spectrophotometric	W91-11334 5A	W91-10918 5C
Determination of Nitrate and Nitrite in Water.	DUTKIEWICZ, R.	
W91-10824 5A	Difficulty of Using Coliphages as 'Indicators'	EDZWALD, J. K.
DOOLETTE, J. B.	and 'Index' Organisms. W91-10661 5A	Removal of Humic Substances and Algae by Dissolved Air Flotation.
Soil and Moisture Conservation Technologies: Review of Literature.	DUWELIUS, R. F.	W91-10751 5F
W91-11565 4D	Description of the Physical Environment and	EFFLER, S. W.
Strategic Issues in Watershed Development.	Coal-Mining History of West-Central Indiana, with Emphasis on Six Small Watersheds.	Optics of Little Sodus Bay.
W91-11564 4D	W91-11576 2E	W91-10980 2H
DORETTI, L.	DWORSKY, L. B.	EHRICH, M.
Use of 2,2-Dimethoxypropane for the Direct Gas Chromatographic-Mass Spectrometric De- termination of Some Organic Compounds in	Breaking the Incrementalist Trap: Achieving Unified Management of the Great Lakes Ecosys-	Sensitive High-Performance Liquid Chromato- graphic Analysis for Toxicological Studies with Carbaryl.
Water.	tem. W91-11025 6A	W91-10920 5A
W91-11245 5A	EAGLESON, P. S.	
DORSEY, J. Marine Monitoring in Heterogeneous Environ-	Hydrologic Science: A Distinct Geoscience. W91-11429 2A	Removal of Heavy Metals and Other Cations From Wastewater Using Zeolites.
ments. W91-11264 5A	EASTER, K. W.	W91-11369 5D
DOUGLAS, A. J.	Regulation of Interbasin Transfers and Con-	EID, E. E.
Aquatic Habitat Measurement and Valuation:	sumptive Uses from the Great Lakes. W91-11384 6E	Egyptian Approach Towards Appropriate Use
Imputing Social Benefits to Instream Flow Levels.	Water Diversion from the Great Lakes as a	of Coastal Zones on the Red Sea. W91-10561 6G
W91-11266 7C	Dynamic Game. W91-11051 6B	
DRIMMIE, R.		EIDSA, G.
Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.	the Central United States.	Biotechnology Degradation and Mitigation of Offshore Oil Spills, Phase 1. Main Report: Tech- nology to Enhance Biodegradation of Oil Spills
W91-11062 5B	W91-11411 2B	State of the Art and Perspectives for Technology Development.
DRIVER, N. E.	EBERHARDT, A. J. Regulation of Lake Ontario Levels.	W91-10735 5G
Techniques for Estimation of Storm-Runoff	W01 11029 6A	EIKEBROKK, B.
Loads, Volumes, and Selected Constituent Con- centrations in Urban Watersheds in the United		Design and Performance of the BIOFISH Water
States.	Runoff Characteristics of COD, BOD, C, N, and	Recirculation System. W91-11548 5D
W91-11094 5E	P Loadings from Rivers to Enclosed Coastal Seas.	W91-11548 5D
DROST, B. W. Geologic Framework of the Columbia Plateau	W91-10521 5B	EILERS, J. M.  Species Composition of Fish Communities in
Aquifer System, Washington, Oregon, and	EDERINGTON, B.	Northern Wisconsin Lakes: Relation to nH
Idaho. W91-11571 2F	Comparison of Pressurized and Gravity Distri- bution Systems for Wastewater Treatment.	W91-10725 5C
	W91-10845 5D	EISLER, R.
DUARTE, C. M.  Macrophyte Standing Crop and Primary Pro	- EDGELL, K. W.	Atrazine Hazards to Fish, Wildlife, and Inverte-
ductivity in Some Florida Spring-Runs. W91-10812	Capillary Column Gas Chromatography With	

EK, M.  Membrane Filtration Combined with Biological	ELLIS, J. New Standards for the Determination of Geos-	ERNST, W.  Contamination of Ponds by Fenitrothion during
Treatment for Purification of Bleach Plant Ef-	min and Methylisoborneol in Water by Gas Chromatography/Mass Spectroscopy.	Forest Spraying.
fluents. W91-11490 5D	W91-11329 5A	W91-11298 5B
EKENGREN, O.	ELLIS, J. B.	ESCARRE, A.
Treatment of Bleach-Plant Effluents with Mem- brane Filtration and Sorption Techniques.	Bacterial Water Quality in Urban Receiving Waters. W91-10633 5B	Hydrological Balance of Two Mediterranean Forested Catchments (Prades, Northeast Spain). W91-10963 2A
	ELMGREN, R.	POLIT PAGANI W NI
EL ABD, H.  Mathematical Modelling for Sulphur Dioxide Removal from Stack Gases in a Fluidized Bed of	Meiofauna of an Experimental Soft Bottom Eco- systemEffects of Macrofauna and Cadmium	ESHLEMAN, K. N.  Acid-Base Status of Pennsylvania Streams: Results from the National Stream Survey.
Activated Sodium Carbonate. W91-11080 5G	Exposure. W91-10519 5C	W91-10726 5B
	ELROD, V. A.	EVANS, G.
EL-AIDI, B.  Nonlinear Earthquake Response of Concrete Gravity Dam Systems.	Determination of Subnanomolar Levels of Iron(II) and Total Dissolved Iron in Seawater by Flow Injection Analysis with Chemilumines-	Watershed Years at Niagara Falls: Canadian and American Policy Responses to New Meanings of Power, 1905-1914.
W91-10754 8F	cence Detection.	W91-11038 6E
EL AMIR, S.	W91-10773 2K	EXNER, D. E.
Effect of Low Salinity Water on Salt Displace- ment in Two Soils.	ELSER, J. J.  Zooplankton Effects on Phytoplankton in Lakes	Farmer-Initiated Project to Promote Sustainable Agriculture in Cooperation with the Extension
W91-11433 2G	of Contrasting Trophic Status. W91-10859 2H	Service.
EL DIWANI, G.  Mathematical Modelling for Sulphur Dioxide	ELSHEBINY, G. M.	W91-11203 3F
Removal from Stack Gases in a Fluidized Bed of	Lead Sorption in Calcareous Soils.	FAHMY, M.
Activated Sodium Carbonate. W91-11080 5G	W91-11453 5B	Treatment of Bleaching Effluents In Aerobic/ Anaerobic Fluidized Biofilm Systems.
	ENCOMIENDA, I.  Health Risk Assessment of Toluene in California	W91-11486 5D
EL-GEUNDI, M. S.  Colour Removal from Textile Effluents by Ad-	Drinking Water.	FAILLAT, J. P.
sorption Techniques. W91-11323 5D	W91-10741 5C	Deforestation and Leaching of Nitrogen as Ni- trates into Underground Water in Intertropical
EL-KOMI, M. M.	ENDOH, T. Vapor Diffusional Growth of Free-Falling	Zones: The Example of Cote d'Ivoire.
Incidence and Ecology of Marine Fouling Organisms in the Eastern Harbour of Alexandria,	Snow Crystals Between -3 and -23 C. W91-10515 2C	W91-11446 2F
Egypt.	ENELL M.	FAIRCHILD, R. W.
W91-10560 5C	Distribution of Halogenated Organic Com-	Hydrology of the Arbuckle Mountains Area, South-Central Oklahoma.
EL-ZANFALY, H. T. Need for New Microbiological Water Quality	pounds (AOX)Swedish Transport to Surround- ing Sea Areas and Mass Balance Studies In Five	W91-11590 2F
Criteria.	Drainage Systems. W91-11506 5B	FAIVRE, M.
W91-10621 5F	ENGER, L.	Efficiency of an Ozoflotation-Filtration Process for the Treatment of the River Thames at
ELDERHORST, W. I. M. Establishment of a Groundwater Research Data	Estimating the Effects on the Regional Precipi- tation Climate in a Semiarid Region Caused by	Walton Works. W91-11268 5F
Center for Validation of Subsurface Flow and Transport Models.	an Artificial Lake Using a Mesoscale Model.	FALCONER, R. A.
W91-10736 2F	W91-10502 2B	Three-Dimensional Numerical Modelling of
ELDRIDGE, R. J.	ENLANDER, I. J.  Variation in the Acidity of Ground and Surface	Wind-Driven Circulation in a Shallow Homoge- neous Lake.
Extraction of Heavy Metals from Sludges and Muds by Magnetic Ion-Exchange.	Waters in Northern Ireland. W91-11407 2H	W91-10992 2H
W91-11145 5D		FAN, D. F.
ELKHATIB, E. A.	ENOCH, G. D. Investigations With Electrodialysis Reversal for	Behavior of the Fungicide MBAMT in Water.
Lead Sorption in Calcareous Soils. W91-11453 5B	the Treatment of Surface Water to Make-Up Water.	W91-11315 5A
ELLEFSON, B, R.	W91-11368 5F	FARAG, A. M. Sensitivity of Greenback Cutthroat Trout to
Effects of the 1988 Drought on Water Resources in Wisconsin.	Treatment of Waste Water From Wet Lime(Stone) Flue Gas Desulfurization Plants	Acidic pH and Elevated Aluminum.
W91-11108 2E	With Aid of Crossflow Microfiltration.	
ELLIOT, W. J.	W91-11371 5D	FARRAH, S. R. Adsorption of Viruses by Diatomaceous Earth
WEPP: Soil Erodibility Experiments for Range- land and Cropland Soils.	EPPEL, D. P. Modelling the Atmospheric Transport of Trace Metals Including the Role of Precipitating	Coated with Metallic Oxides and Metallic Per- oxides.
W91-10512 2J	Clouds.	W91-10659 5A
ELLIOTT, C. M.  Effect of a Chelating Agent (DTPA) on Anaero-	W91-11251 5B	Laboratory Studies of Virus Survival During
bic Wastewater Treatment in an Upflow Sludge Blanket Filter.	EPPERSON, C. E. Characterization of Radioactivity in Hot Springs	Aerobic and Anaerobic Digestion of Sewage Sludge.
W91-11277 5D	National Park, Arkansas. W91-10846 2K	W91-11319 5D
ELLIOTT, H. A.	ERKELENS, C.	FARRELL, M. P.
Agronomic Effects of Land Application of Water Treatment Sludges.	Analysis of Halogenated Acetic Acids in Dutch	Atmospheric Carbon Dioxide and the Global Carbon Cycle: The Key Uncertainties.
W91-11459 4C	Drinking Water. W91-10938 5F	W91-11068 5B
ELLIOTT, W. P.	ERLIKHMAN, B. L.	FAWZI, M. A.
Relation of Atmospheric CO2 to Tropical Sea and Air Temperatures and Precipitation.	Stability of Hydropower Construction Programs.	Egyptian Approach Towards Appropriate Use of Coastal Zones on the Red Sea.
W91-11002 2B	W91-11294 8C	W91-10561 6G

FAYE, R. E. Ground-Water Flow and Stream-Aquifer Rela- tions in the Northern Coastal Plain of Georgia	FIELD, R. Urban Storm-Induced Discharge Impacts. W91-10745 5B	FLETCHER, B. P. St. Johns Bayou Pumping Station, Missouri: Hydraulic Model Investigation.
and Adjacent Parts of Alabama and South Caro- lina.	FIELDING, T.	W91-11588 8C
W91-11598 2F	Preliminary Data Summary for the Pesticide Chemicals Point Source Category.	FLOSSNER, D.
FAZELI-MATIN, S. Sediment Denitrification Potential in the Elizabeth River, Virginia. W91-11537 5C	W91-10739 5B  FILIP, Z.  Bdellovibrio sp.: A Predator under Groundwater Conditions. A Short Communication.	History of Cladocera in the Kleiner Barsch-See, an Acidic, Calcium-Poor, Marshy Pond in the Middle European Flatland (Die Geschichte der Cladocerenfauna des Kleinen Barsch-Sees, eines Sauren, Kalkarmen Moorweihers im Mitteleuro-
FEDORAK, P. M. Anaerobic Treatability of a Phenolic Coal Con-	W91-10676 5B	paischen Flachland). W91-11515 2H
version Wastewater After Diisopropyl Ether	FILIPSSON, S.  Treatment of Bleach-Plant Effluents with Mem-	FODA, M. A.
Extraction. W91-10939 5D	brane Filtration and Sorption Techniques. W91-11489 5D	Fluidization of Marine Mud by Waves.
FEDORISHCHAK, M. R. P. Secondary Salinization of Soils of the Dniester Delta Floodplain.	FINDLAY, J. S. Effect of Dissolved Nutrients and Inorganic Suspended Solids on the Survival of E. coli in	W91-10533 5B FOGARASI, S. Variation of the Stable Isotopes of Water with
W91-10917 2G	Seawater.	Altitude in the Saint Elias Mountains of Canada.
FEENSTRA, S.	W91-10638 5B	W91-11220 2C
Depth of Fractures and Active Ground-Water Flow in a Clayey Till Plain in Southwestern Ontario.	FINKELSTEIN, P. L.  Spatial Distribution of Precipitation Seasonality in the United States.	FOLKE, J.  Regulatory Requirements for Pulp and Paper  Mill Polyant Control Spiratific Pages and Con-
W91-10959 2F	W91-11414 2B	Mill Effluent Control: Scientific Basis and Con- sequences. W91-11470 5G
Method for Assessing Residual NAPL Based on Organic Chemical Concentrations in Soil Sam-	FINNVEDEN, G. Treatment Technologies for Organochlorine-	
ples. W91-10797 5A	Containing Sludges and Concentrates from Ex- ternal Treatment of Pulp and Paper	FOLLETT, M. R. Water Rate Structure for Demand Management
FEIFAREK, B. P.	Wastewaters. W91-11500 5D	in the Regional Municipality of Waterloo. W91-11049 6C
Drift of the Characin Larvae, Bryconamericus deuterodonoides, During the Dry Season from	FIO, J. L.	FONTAINE, T. D.
Andean Piedmont Streams. W91-11560 2H	Ground-Water Flow and Solute Movement to Drain Laterals, Western San Joaquin Valley,	Great Lakes Total Phosphorus Model: Post Audit and Regionalized Sensitivity Analysis.
FENT, K.	California. I. Geochemical Assessment. W91-10768 5B	W91-10974 2H
Bioaccumulation, Elimination and Metabolism of Triphenyltin Chloride by Early Life Stages of Minnows Phoxinus phoxinus.	Ground-Water Flow and Solute Movement to Drain Laterals, Western San Joaquin Valley,	FONTENOT, J. P. Influence of Flooded Soil on Chemical Compo- sition of Annual Ryegrass and Digestibility by
W91-10877 5B	California. II. Quantitative Hydrologic Assess- ment.	Meadow Voles. W91-11536 2I
Phenyltins in Water, Sediment, and Biota of Freshwater Marinas. W91-11342 5B	W91-10769 5B	FORD, J. S.
FERDELMAN, T.	FISCHEDER, R. Growth and Inactivation Kinetics of Mycobac-	Acoustic Parametric Array for Measuring the Thickness and Stratigraphy of Contaminated
Iodine Chemistry in the Water Column of the Chesapeake Bay: Evidence for Organic Iodine	teria in Biofilms. W91-10642 5B	Sediments. W91-10981 2J
Forms. W91-10496 2L	FISCHER, E. E. Statistical Summaries of Selected Iowa Stream-	FORTES, M. D.
FERDELMAN, T. G.	flow Data Through September 30, 1988.	Seagrass-Mangrove Ecosystems Management: A
Sulfur Enrichment of Humic Substances in a	W91-10770 2E	Key to Marine Coastal Conservation in the ASEAN Region.
Delaware Salt Marsh Sediment Core. W91-11258 2L	FISHER, N. S. Assimilation of Metals in Marine Copepods and	W91-10539 5G
FERGUSON, J. F.	its Biogeochemical Implications. W91-10866 2L	FORTI, M. C. Rainwater and Throughfall Chemistry in a
Investigation of Anaerobic Removal and Degra- dation of Organic Chlorine from Kraft Bleach-	FLAHERTY, P. A.	'Terre Firme' Rain Forest: Central Amazonia. W91-11218 2B
ing Wastewaters. W91-11492 5D	Fate and Effects of Semivolatile Organic Pollut- ants During Anaerobic Digestion of Sludge.	FORTUNO, J. M.
FERM, R.	W91-10884 5D	Mercury Body Burden and Otolith Characteris-
Integrated Management of the Baltic Sea. W91-10580 5G	FLATAU, G. N. Protective Effect of Glycine Betaine on Survival	tics of Bluefin Tuna from the Northwest Medi- terranean (Balearic Sea).
FERRETTI, O. Trace Element Distribution in Surficial Sedi-	of Escherichia coli Cells in Marine Environ- ments. W91-10637 5B	W91-10881 2L FOSTER, C, H, W,
ments of the Northern Tyrrhenian Sea: Contri-	W91-10637 5B FLECKER, A. S.	What Makes Regional Organizations Succeed or
bution to Heavy-Metal Pollution Assessment. W91-11444 5A	Drift of the Characin Larvae, Bryconamericus	Fail. W91-11005 6A
FIECHTER, A.	deuterodonoides, During the Dry Season from Andean Piedmont Streams.	FOSTER, G. R.
Thermophilic Aerobic Stabilisation. W91-11134 5D	W91-11560 2H	Advances in Wind and Water Erosion Predic-
FIELD, J. A.	FLEISCHMANN, T. UV Disinfection: Short Term Inactivation and	tion. W91-10509 2J
Future Perspectives for the Anaerobic Treatment of Forest Industry Wastewaters.	Revival. W91-10680 5F	RUSLE: Revised Universal Soil Loss Equation.
W91-11478 5D	FLEMING, C. S.	W91-10510 2J
Treatment and Detoxification of Aqueous Spruce Bark Extracts by Aspergillus niger.	Implications of Full-Cost Recovery Water Rates on Irrigated Farms in Saskatchewan.	WEPP: A New Generation of Erosion Predic- tion Technology.
W91-11481 5D	W91-11054 6C	W91-10511 2J

Influence of Flooded Soil on Chemical Compo-	Vapor Diffusional Growth of Free-Falling	Colonization in an Unshaded Stream at Shillong
sition of Annual Ryegrass and Digestibility by Meadow Voles.	Snow Crystals Between -3 and -23 C. W91-10515 2C	(Meghalaya, India). W91-11451 2E
W91-11536 2I	FURBISH, D. J.	
FOSTER, K. E. Residential Water Conservation: Casa Del Agua. W91-10814 3D	Response of Water Level in a Well to a Time Series of Atmospheric Loading Under Confined Conditions.	GAUTHIER, M. J.  Protective Effect of Glycine Betaine on Survival of Escherichia coli Cells in Marine Environ-
FOWLER, S. W.	W91-11236 2F	ments. W91-10637 5B
Assimilation of Metals in Marine Copepods and	FURUTANI, S. Eutrophication Mechanisms of Coastal Seas in	
its Biogeochemical Implications. W91-10866 2L	Yamaguchi Prefecture. W91-10593 5B	GAVAGHAN, P. D.  Determining Giardiasis Prevalence by Examina- tion of Sewage.
FOX, G.	FUSTEC, E.	W91-10646 5A
Economic Assessment of the Water Quality Benefits of Conservation Tillage on Southwestern Ontario Cropland. W91-11050 3F	Nitrate Removal by Denitrification in Alluvial Ground Water: Role of a Former Channel. W91-10909 5B	Distribution of Giardia Cysts in Wastewater. W91-10649 5B
FRANCO, E.	GABRIELIDES, G. P.	GEHRINGER, P.
Prospective Epidemiological Study of Drinking Water Related Gastrointestinal Illnesses.	Man-Made Garbage Pollution on the Mediterra- nean Coastline. W91-10569 5B	Treatment of Pulp-Bleaching Effluents by Acti- vated Sludge, Precipitation, Ozonation and Irra- diation.
W91-10618 5B	GADBOIS, L. E.	W91-11491 5D
FRAPE, S.	Environmental Feasibility of Using Wetlands to	GELFAN, A. N.
Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.	Treat Runoff Pollution. W91-10737 5D	Dynamic-Stochastic Models of Rainfall and Snowmelt Runoff Formation.
W91-11062 5B	GAJARDO, R.  Concentration of Hepatitis A Virus in Environ-	W91-10967 2A
FREDERICK, G. L.	mental Samples. W91-10658 5A	GELLER, A.
Waste Stabilization Ponds in Grand Cayman, Cayman Islands.		Closing Paper Mill Whitewater Circuits by In- serting an Anaerobic Stage with Subsequent
W91-10691 5D	GAJENDRAGAD, M. R. Studies on Assessment of Water Balance and Its	Treatment.
FREDLUND, D. J.	Quality in Gurpur River Basin, Karnataka State,	W91-11477 5G
Numerical Modelling of Vertical Ground Move-	India. W91-11065 5B	GELLMAN, I.
ments in Expansive Soils. W91-10945 2G	GALGANI. F.	Goals, Regulations and Information Needs for
FREI, J. K.	Measurement of the Effect of Organic Pollution	Wastewater Discharge Management-An Ameri- can Perspective.
Effects of Acid Rain on Epiphytic Orchid	on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers.	W91-11471 5G
Growth. W91-11076 5C	W91-10469 5A	GENCSOY, H. T.
FRENCH, M. S.	GAMACHE, J. F.	Design of Economic and Efficient Treatment Station for Acidic Streams.
Activity of Peracetic Acid on Sewage Indicator Bacteria and Viruses.	Convective Cell in a Hurricane Rainband. W91-11422 2B	W91-11077 5G
W91-10683 5D	GAN, T. Y.	GENSEMER, R. W.
FRENZEL, P. F.	Interpretation of Hydrologic Effects of Climate Change in the Sacramento-San Joaquin River	Effects of pH and Aluminum on the Growth of the Acidophilic Diatom Asterionella ralfsii var.
Geohydrology and Simulation of Ground-Water Flow in the Mesilla Basin, Dona Ana County,	Basin, California. W91-11552 5C	americana. W91-10862 2H
New Mexico, and El Paso County, Texas.	GANOULIS, J. G.	W91-10862 2H
	Water Quality Assessment and Protection Meas-	GENTHE, B.
FRERICHS, S.  Regulation of Interbasin Transfers and Con-	ures of a Semi-Enclosed Coastal Area: The Bay of Thermaikos (NE Mediterranean Sea).	Detection of Rotavirus in South African Waters: A Comparison of a Cytoimmunolabelling Tech-
sumptive Uses from the Great Lakes.	W91-10534 5G	nique with Commercially Available Immunoas-
W91-11384 6E	GARDNER, A.	says. W91-10660 5A
FREYER, A. J.  Microbial Dechlorination of the Herbicide Me-	Legislative Implementation of Integrated Catch- ment Management in Western Australia.	GENTILE, J. H.
tolachlor.	W91-11374 6E	Application of a Hazard Assessment Research
W91-11377 5B	GARRY, J. D.	Strategy to the Ocean Disposal of a Dredged
FROSTELL, B. Membrane Filtration Combined with Biological	Hydrogeology of the Valley-Fill Aquifer at Owego, Tioga County, New York. W91-11105 2F	Material: Overview. W91-10740 5E
Treatment for Purification of Bleach Plant Ef- fluents.	GARWOOD, E. A.	Hazard Assessment Research Strategy for
W91-11490 5D	Hydrological Consequences of Artificial Drain- age of Grassland.	Ocean Disposal. W91-11551 5E
Treatment Technologies for Organochlorine-	W91-11347 2G	GEORGE, D. G.
Containing Sludges and Concentrates from Ex- ternal Treatment of Pulp and Paper	GASSMANN, L. Wastewater and Giardia Cysts.	Three-Dimensional Numerical Modelling of Wind-Driven Circulation in a Shallow Homoge-
Wastewaters. W91-11500 5D	W91-10648 5B	neous Lake.
	GATRONE, R. C.	W91-10992 2H
FRY, B.  Role of Seasonal Turnover in Lake Alkalinity	Synthesis and Decomposition of Novel Organo- phosphorus Complexants.	GERBA, C. P.
Dynamics.	W91-11372 5D	Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water.
W91-10861 2H	GAUR, J. P.	W91-10667 5A
FUELBERG, H. E.  Assessment of VAS-Derived Retrievals and Pa-	Inhibition of NO3(-), NH4(+), and PO4(3-) Uptake in Anabaena doliolum Exposed to a Pe-	Detection of Rotaviruses in Water by Gene
rameters used in Thunderstorm Forecasting.	troleum Olianosena donotum Exposed to a Pe-	Probes.

Use of Risk Assessment for Development of	GIRDWOOD, R. W. A.	GOMEZ-BELINCHON, J. I.
Microbial Standards.	Occurrence and Viability of Giardia spp. Cysts	Volatile Organic Compounds in Two Polluted
W91-10619 5G	in UK Waters. W91-10647 5B	Rivers in Barcelona (Catalonia, Spain). W91-10887 5B
GERMANN, P. F.		
Throughflow and Solute Transport in an Isolat-	GIST, G. L. New Dead Sea.	GOMEZ-LAHOZ, C.
ed Sloping Soil Block in a Forested Catchment. W91-10993 2G	W91-10504 5C	Soil Clean Up by In-situ Aeration: VI. Effects of
	GJESSING, E. T.	Variable Permeabilities. W91-11317 5G
GHOSH, M. Regulatory Influence of Water Current on Algal	Algicidal and Chemical Effect of u.vRadiation	
Colonization in an Unshaded Stream at Shillong	of Water Containing Humic Substances.	GOMYODA, M.
(Meghalaya, India).	W91-10941 5F	Analysis of Precipitation Chemistry Measure- ments in Shimane, Japan.
W91-11451 2E	GLADDEN, J. B.	W91-10472 2B
GIANESSI, L. P.	Comprehensive Cooling Water Study, Final	
National Pesticide Usage Data Base.	Report. Volume I: Summary of Environmental	GONG, G.
W91-11176 7C	Effects. W91-10729 5B	Variation of Moisture Conditions in China during the Last 2000 Years.
GIANG, B. Y.		W91-10971 2A
Aqueous Photolysis of Napropamide.	GLAISTER, P. Similarity Solutions of the Shallow Water Equa-	
W91-11376 5B	tions.	GONG, Y.
GIBLIN, A. E.	W91-10987 8B	Factors Affecting the Relationship Between the NBOD Values and the Amounts of Nitrogenous
Role of Seasonal Turnover in Lake Alkalinity	GLASER, P. H.	Pollutants: A Field Study on the Lee River.
Dynamics.	Fate of Silicate Minerals in a Peat Bog.	W91-10940 5C
W91-10861 2H	W91-10789 2H	CONTURD I D
GIBSON, S. A.	GLATTFELDER, A. H.	GONTHIER, J. B. Geologic Framework of the Columbia Plateau
Stimulation of the Reductive Dechlorination of	Experience with Low-Head HydroPlant Fre-	Aquifer System, Washington, Oregon, and
Tetrachloroethene in Anaerobic Aquifer Micro- cosms by the Addition of Toluene.	quency Control.	Idaho.
W91-11344 5B	W91-11214 8C	W91-11571 2F
	GOBAS, F. A. P. C.	GOODWIN, J.
GIESE, R. F.	Bioconcentration of Chlorinated Aromatic Hy-	Preliminary Data Summary for the Pesticide
Permeability of Soils with Organic Fluids. W91-10783 5B	drocarbons in Aquatic Macrophytes.	Chemicals Point Source Category.
	W91-11338 5B	W91-10739 5B
GIFFORD, J. S.  Development of Environmental Control Legis-	GODFROY, B.	GOODWIN, P.
lation and Effluent Standards for Australasian	Use of Municipal Sewage Sludge in Agriculture:	Seasonal Influences on the Sediment Transport
Wood Processing Industries.	The Role of the Water Authorities. W91-11138 5D	Characteristics of the Sacramento River, Cali-
W91-11472 5G		fornia.
GIGER, W.	GOERTZ, H. Comparison of Mean Annual Runoff Estimates	W91-10847 2J
Accumulation of Refractory 4-Nonylphenol	in the Canadian Portion of the Great Lakes	GORDON, A. S.
During Mesophilic Anaerobic Sludge Stabiliza-	Basin.	Sediment Denitrification Potential in the Eliza-
tion. W91-10707 5D	W91-11020 2E	beth River, Virginia.
W91-10/0/	GOEWIE, C. E.	W91-11537 5C
Pathway Analysis of Selected Organic Chemi-	Application of HPLC Column-Switching in Pes-	GORDON, J. L.
cals from Sewage to Agricultural Soil. W91-11123 5B	ticide Residue Analysis.	Hydroelectric Turbine Setting: A Rational Ap-
W91-11123 5B	W91-11308 5A	proach.
GILBERT, B. K.	GOKSOYR, A.	W91-11274 8C
U.S. Geological Survey Federal-State Cooperative Water-Resources Program Fiscal Year 1989.	Immunochemical Detection of Cytochrome	GORECKI, T.
W91-11109 7B	P450IA1 Induction in Cod Larvae and Juveniles Exposed to a Water Soluble Fraction of North	Continuous Flow Thin-Layer Headspace
	Sea Crude Oil.	(TLHS) Analysis. I. Conductometric Determi-
GILDEMEISTER, H. H.	W91-10871 5A	nation of Volatile Organic Halogens (VOX) in Tap Water.
Sludge Dewatering Technology in Perspective. W91-11128 5D	GOLDEN, B. F.	W91-11256 5A
	Interstate Cooperation in Dealing with Growth	
GILL, J. D.  Graphical Method for Determining the Coeffi-	Related Water Quality Impacts on the Chesa-	GORSKY, Y. N.  Chemical Composition of the Interstitial Water
cient of Consolidation cv from a Flow-Pump	peake Bay.	in Bottom Sediments of Tyrrhenian Sea (West-
Permeability Test.	W91-11009 6E	ern Mediterranean): Diagenetic Processes.
W91-11393 7C	GOLDMAN, C. R.	W91-10880 2J
GILLESPIE, W. J.	Increased Precipitation Acidity in the Central	GOSS, K. U.
Goals, Regulations and Information Needs for	Sierra Nevada. W91-10471 5B	Determination of Effective Diffusion Coeffi-
Wastewater Discharge ManagementAn Ameri-		cients for Gaseous and Dissolved Organic Sub-
can Perspective.	Potential Effects of Global Warming on the	stances in Soil Material Using a 'Stopped Elu-
W91-11471 5G	Primary Productivity of a Subalpine Lake. W91-10819 2H	tion' Method with HPLC and GC.
GILMORE, T. J.		W91-10802 7E
Installation of the Westbay Multiport Ground-	Zooplankton Effects on Phytoplankton in Lakes	GOVIND, R.
Water Sampling System in Well 699-43-42K Near The 216-B-3 Pond.	of Contrasting Trophic Status. W91-10859 2H	Fate and Effects of Semivolatile Organic Pollut
W91-10720 7B		ants During Anaerobic Digestion of Sludge.
	GOLIK, A.	W91-10884 5D
GILMOUR, R. A.  Occurrence and Viability of Giardia spp. Cysts	Man-Made Garbage Pollution on the Mediterra- nean Coastline.	GRABOW, N. A.
in UK Waters.	W91-10569 5B	Most Probable Number Method for the Enu-
W91-10647 5B		meration of Legionella Bacteria in Water.
GIORGI, F.	GOLTZ, M. N.  Analytical Modeling of Aquifer Decontamina-	W91-10640 5A
Approaches to the Simulation of Regional Cli-	tion by Pumping When Transport is Affected by	Occurrence of Legionella Bacteria in Cooling
mate Change: A Review.	Rate-Limited Sorption.	Towers in South Africa.
W91-11427 5C	W91-11235 5G	W91-10641 5E

GRABOW, W. O. K.	GRIGORJEV, V. Y.  Dynamic Simulation Model of Vertical Infiltra-	GUETTIER, P.
Assessment of Methods for the Microbiological Analysis of Shellfish. W91-10695 5A	tion of Water in Soil. W91-10968 2A	Sludge Recycling in Agriculture Compared with Other Disposal Methods in France. W91-11137 5E
Comparison of Methods for the Isolation of a Wide Range of Viruses from Shellfish. W91-10698 5A	GRILLO, X. Nitrate Removal by Denitrification in Alluvial Ground Water: Role of a Former Channel. W91-10909 5B	GUIBERT, J. M. Miniaturized Fluorogenic Assays for Enumera- tion of E. coli and Enterococci in Marine Water
Detection of Rotavirus in South African Waters: A Comparison of a Cytoimmunolabelling Technique with Commercially Available Immunoas-	GRIMALT, J. O. Volatile Organic Compounds in Two Polluted	W91-10639 5A GUIDI, G. V. Modifications of Some Physical Properties in
says. W91-10660 5A	Rivers in Barcelona (Catalonia, Spain). W91-10887 5B GRIMASON, A. M.	Two Compost-Amended Italian Soils. W91-11148 5E
Microbiological Methods for Safety Testing of Drinking Water Directly Reclaimed from Wastewater. W91-10613 5A	Occurrence of Cryptosporidium spp. Occysts in Scottish Waters, and the Development of a Fluorogenic Viability Assay for Individual Cryptosporidium Occysts.  W91-10645  5B	GUIGNE, J. Y.  Acoustic Parametric Array for Measuring the Thickness and Stratigraphy of Contaminated Sediments.
Most Probable Number Method for the Enumeration of Legionella Bacteria in Water. W91-10640 5A	GRIMM, J. W. Statistical Analysis of Errors in Estimating Wet Deposition Using Five Surface Estimation Algo-	W91-10981 2.  GUINEZ, R.  Effects of Pollution on Heterozygosity in the
Occurrence of Male-Specific and Somatic Bac- teriophages in Polluted South African Waters. W91-10662 5B	rithms. W91-10474 7B	Barnacle Balanus amphitrite (Cirripedia: Thoracica). W91-10518
GRAHAM, J. D.  Assessment of Agricultural Nutrient Point Source Discharge from Tile Drains, Spring and Overland Runoff from Two Farms, Dauphin County, Pennsylvania.	GRIMVALL, A.  Formation of Chlorophenols and Related Compounds In Natural and Technical Chlorination Processes.  W91-11508  5B	GUIOT, S. R.  Effect of NSSC Spent Liquor on Granule For mation and Specific Microbial Activities Is Upflow Anaerobic Reactors.  W91-11482 5I
W91-11600 5B  GRANT, L. O.  Effect of Decoupled Low-Level Flow on	Organohalogens of Natural and Industrial Origin In Large Recipients of Bleach-Plant Effluents. W91-11505 5B	Modeling the Upflow Anaerobic Sludge Bed Filter System: a Case with Hysteresis.
Winter Orographic Clouds and Precipitation in the Yampa River Valley. W91-11410 2B	GRODY, N. C. Classification of Snow Cover and Precipitation Using the Special Sensor Microwave Imager. W91-11219 7B	W91-11321 5E GUISS, C. Seasonal Variation of Biomass and Production
GRASSL, H.  Modelling the Atmospheric Transport of Trace Metals Including the Role of Precipitating Clouds. W91-11251 5B	GROHMANN, A.  Disinfection Capability in Water for Swimming and Bathing Pools: A Simple Method for Their Evaluation in Practice.	Dynamics for Above and Belowground Components of a Spartina alterniflora Marsh in th Euhaline Sector of Paranagua Bay (SE Brazil) W91-10495
GRAU, P. Criteria for Nutrient-Balanced Operation of Ac-	W91-10684 5F  GROSS, M. Comparison of Pressurized and Gravity Distri-	GULLICHSEN, J.  Process Internal Measures to Reduce Pulp Mil Pollution Load.
tivated Sludge Process. W91-11493 5D	bution Systems for Wastewater Treatment. W91-10845 5D	W91-11473 50 GUNAWARDENA, E. R. N.
GRAY, R. M. National Program for Soil and Water Conserva- tion. Its Effect on USDA Services. W91-11169 3F	GROSS, M. L.  Major Incident of Dioxin Contamination: Sediments of New Jersey Estuaries.  W91-11341  5B	Soil Water Dynamics Related to Waterloggin in a Sloping Catchment. W91-10906
GREENE, E. A. Use of Electronic Data-Logging Equipment to Monitor Hydrologic Parameters in a Humid	GROTCH, S. L. Observational and Theoretical Studies of Greenhouse Climate Effects.	GUNNARSSON, L. Conductivity for Nutrient Control In CTM Wastewater Treatment. W91-11495 51
Cave Environment in Wind Cave National Park, South Dakota. W91-11389 7B	W91-11067 5C GRUDPAN, K.	GUO, Y.
GREENFIELD, P. F. Foaming in Activated Sludge Plants: A Survey in Queensland, Australia and an Evaluation of	Low Cost Flow Injection Analysis for Cadmium Using 2-(2-benzothiazolylazo) -4,5-Dimethylphenol.	Computation of Uniform Flow in Open Char nels with Flood Plains. W91-11281
Some Control Strategies. W91-11328 5D	W91-11379 5A GRUNDLINGH, M.	GUPTA, M. Ultrastructural and Biochemical Effects of Cad
GREGORY, J. M. Precipitation in Britain: An Analysis of Area- Average Data Updated to 1989.	Evaluation of Fecal Enterococci Isolation Media to Indicate Fecal Pollution in Chlorinated Water. W91-10626 5F	mium on the Aquatic Fern Marsilea minut Linn. W91-10829
W91-10973 2B GRENELL, P.	GRZEBYK, D.  Measurement of the Effect of Organic Pollution	GUPTA, U. S. Seasonal Variations and Relationships of Different Physics of Property in New York (New York)
Non-Regulatory Approaches to Management of Coastal Resources and Development in San Francisco Bay.	on Marine Organisms: Rapid Determination of EROD Induction Using Plate Readers. W91-10469 5A	ent Physico-chemical Characteristics in Newl Made Tawa Reservoir. W91-11528
W91-10576 2L  GRIFFITHS, F. J.  Change in Pore Size Distribution Owing to Secondary Consolidation of Clays. W91-10774 8D	GUARIN, F. Y. Water Quality Management Issues in Lingayen Gulf, Philippines and Some Proposed Solutions. W91-10523 5G	GUPTA, V. K.  Simple Spectrophotometric Determination of Endosulfan in River Water and Soil.  W91-11314  54
GRIGARICK, A. A.  Effect of Pesticide Treatments on Nontarget Organisms in California Rice Paddies.  W91-10835 5C	GUERIN, M. R. Direct Sampling Ion Trap Mass Spectrometry for the Rapid Determination of Volatile Organ- ics in Environmental Matrices. W91-11555 5A	HAARS, A.  Decrease of Pollutant Level of Bleaching E fluents and Winning Valuable Products by Successive Flocculation and Microbial Growth.  W91-11488 51

5D

WALCE DAY	TANDO O D	
HAAS, P. M. Towards Management of Environmental Prob- lems in Egypt. W91-11373 6G	HAINES, G. B. Distribution, Habitat Use, and Growth of Age-0 Colorado Squawfish in the Green River Basin, Colorado and Utah.	HAN, U. J.  Three-Dimensional Simulation of Airflow and Orographic Rain Over the Island of Hawaii. W91-10517  2B
	W91-11534 2H	W91-10517 2B
HABERER, K. Multimethod for Pesticides in Soil at Trace	HATBORD V I	HAN, Z.
Level. W91-11309 5A	HALFORD, K. J.  Geohydrology and Simulation of Flow in the Chicot Aquifer System of Southwestern Louisi-	Environmental Assessment of Wastewater Marine Disposal of Xiaogang Zone, Ningbo. W91-10570 5E
HABERL, R.	ana. W91-11100 2F	HANNAH, D. J.
Treatment of Pulp-Bleaching Effluents by Acti-		Identification of Dioxin Sources In an Integrated
vated Sludge, Precipitation, Ozonation and Irra- diation. W91-11491 5D	HALL, C. A. S.  Effects of Land Use Alteration on Tropical Carbon Exchange.	Wood Processing Facility. W91-11475 5B
HABETS, L. H. A.	W91-11072 4C	HANSEN, K.
Anaerobic Treatment of Bleached TMP and CTMP Effluent In the BioPAQ UASB System. W91-11501 5D	HALL, D. K. Satellite-Derived Reflectance of Snow-Covered Surfaces in Northern Minnesota.	Fertility of Workers Chronically Exposed to Chemically Contaminated Sewer Wastes. W91-11316 5D
Biotechnological Sulphide Removal from Ef-	W91-11353 7C	HANSEN, P. D.
fluents.	HALL, J. E.	Effect of 3,4-Dichloroaniline on the Early Life
W91-11502 5D	Methods of Applying Sewage Sludge to Land:	Stages of the Zebrafish (Brachydanio rerio): Re-
HABLE, M.	A Review of Recent Developments. W91-11119 5E	sults of a Comparative Laboratory Study. W91-10828 5A
Determination of Nitroaromatics and Nitramines in Ground and Drinking Water by Wide-Bore		TANGON D. T.
Capillary Gas Chromatography.	New Developments in Sampling Sludge Treated Soils.	HANSON, R. L. Hydrology of the Arbuckle Mountains Area,
W91-11262 5A	W91-11158 5A	South-Central Oklahoma.
HACHMEISTER, L. E.	HALL, P.	W91-11590 2F
Brine-Induced Advection of Dissolved Aromat-	Three-Dimensional Numerical Modelling of	HANTZSCHE, T.
ic Hydrocarbons to Arctic Bottom Waters. W91-11340 5B	Wind-Driven Circulation in a Shallow Homoge-	Health Risk Assessment of Water Contaminants
	neous Lake. W91-10992 2H	Using Baseline Data of Cancer Incidence in Dif-
HACKER, J.  Pulsed Field Electrophoresis of Genomic Re-	W91-10992 2H	ferent Water Supply Areas. W91-10614 5F
striction Fragments for the Detection of Noso-	HALL, T.	
comial Legionella pneumophila in Hospital	Rainfall Interception by Trees of Pinus radiata and Eucalyptus viminalis in a 1300 mm Rainfall	HARADA, K.  Modern Environmental Assessment Procedures
Water Supplies. W91-10836 5A	Area of Southeastern New South Wales: I.	for Enclosed Seas.
W91-10836 5A	Gross Losses and Their Variability.	W91-10564 6G
HAENI, F. P.	W91-11345 2D	HARASHIMA, A.
Application of Ground-Penetrating-Radar Meth- ods in Hydrogeologic Studies.	Rainfall Interception by Trees of Pinus radiata	Field Survey and Hydraulic Study of 'Aoshio' in
W91-10956 7B	and Eucalyptus viminalis in a 1300 mm Rainfall	Tokyo Bay.
HAFFNER, G. D.	Area of Southeastern New South Wales: II. In- fluence of Wind-Borne Precipitation.	W91-10529 5C
Bioconcentration of Chlorinated Aromatic Hy-	W91-11346 2D	HARBERS, A. E.
drocarbons in Aquatic Macrophytes.	HALL PRICE M. A.	Foaming in Activated Sludge Plants: A Survey
W91-11338 5B	HALLFRISCH, M. A.  Application of the DRASTIC Mapping System	in Queensland, Australia and an Evaluation of Some Control Strategies.
HAGEN, A.	for Evaluating Ground Water Pollution Poten-	W91-11328 5D
Flow-Rate Variated HPLC-/EC-Determination of Phenols.	tial in Ohio. W91-11178 5B	HADDWICK D.I.
W91-11257 5A	W91-111/6	HARDWICK, R. I.  Changes with Time of the Transport Rate of
HAGER, W. H.	HALSTEAD, J. M.	Sediment Mixtures.
Correction Coefficients for Uniform Channel	Ground Water Contamination from Agricultural Sources: Implications for Voluntary Policy Ad-	W91-10988 7B
Flow.	herence from Iowa and Virginia Farmer's Atti-	HARISCH, G.
W91-11282 2E	tudes.	Biochemical and Histochemical Observations on
HAGGBLOM, M.	W91-11437 5G	Effects of Low-Level Metal Load (Lead, Cad- mium) in Different Organ Systems of the Fresh-
Biodegradability of Chlorinated Organic Com- pounds In Pulp Bleaching Effluents.	HALVERSON, N. V.	water Crayfish, Astacus astacus L. (Crustacea:
W91-11484 5D	Comprehensive Cooling Water Study, Final Report. Volume I: Summary of Environmental	Decapoda).
HAHN, T.	Effects.	W91-10827 5B
Behaviour of Pathogenic Bacteria, Phages and	W91-10729 5B	HARKNESS, W. E.
Viruses in Groundwater During Transport and	HAMANO, N.	Report of the River Master of the Delaware
Adsorption. W91-10672 5B	Numerical Simulation of Water Quality in	River, for the Period December 1, 1988-November 30, 1989.
	Tokyo Bay. W91-10528 5B	W91-10765 4A
Difficulty of Using Coliphages as 'Indicators' and 'Index' Organisms.	W91-10326	
W91-10661 5A	HAMEED, S. Variation of Moisture Conditions in China	HARP, G. L. Aquatic Macroinvertebrates of the St. Francis
Field Experiments with Microbiological Tracers	during the Last 2000 Years.	Sunken Lands in Northeast Arkansas.
in a Pore Aquifer.	W91-10971 2A	W91-10844 4C
W91-10673 5B	HAMER, G.	HARPER, D. J.
Transport of Microorganisms in the Under-	UV Disinfection: Short Term Inactivation and	Distribution of Dissolved Cadmium, Lead and Copper in the Bristol Channel and the Outer
ground: Processes, Experiments and Simulation	Revival. W91-10680 5F	Severn Estuary.
Models. W91-10674 5B		W91-10925 5B
	HAMMETT, K. M. Land Use, Water Use, Streamflow Characteris-	HARRISON, P. G.
HAID, B. H. Flow Through Gated Conduits at Partial and	tics, and Water-Quality Characteristics of the	Balance of Nutrient Losses and Gains in Sea-
Full Gate Openings.	Charlotte Harbor Inflow Area, Florida.	grass Meadows.
W91-11276 8C	W91-10771 4C	W91-10867 2L

## HARSHENDRA, K.

HARSHENDRA, K.	F-Specific RNA Bacteriophages as Model Vi-	HEIMANN, D.
Studies on Assessment of Water Balance and Its Quality in Gurpur River Basin, Karnataka State,	ruses in UV Disinfection of Wastewater. W91-10682 5D	Squall Line in Southern Germany: Kinematics and Precipitation Formation as Deduced by Ad-
India. W91-11065 5B	Production and Control of Reference Materials	vanced Polarimetric and Doppler Radar Meas- urements.
HART, L. E.	for Water Microbiology. W91-10623 5A	W91-11420 2B
Dioxin Contamination and Growth and Devel-	Virological Quality of Recreational Waters in	HEIMES, F. J.
opment in Great Blue Heron Embryos. W91-10837 5C	the Netherlands.	Character and Evolution of the Ground-Water
	W91-10653 5B	Flow System in the Central Part of the Western San Joaquin Valley, California.
HARTIG, J. H. Successes and Challenges in Developing and	HAWARI, J. A.	W91-10772 2F
Implementing Remedial Action Plans to Restore	Effect of NSSC Spent Liquor on Granule For- mation and Specific Microbial Activities In	HEINONEN, P.
Degraded Areas of the Great Lakes. W91-11030 6A	Upflow Anaerobic Reactors.	Eutrophication of Pulp and Paper Wastewater
		Recipients. W91-11509 5C
HARTMANN, H. C. Institutional Morass: Constraints and Opportuni-	HAWKER, P. J.  Avalon Lakes: An Environmental Opportunity. W91-11362 6G	HEINZ, G. H.
ties for Issue Management. W91-11036 6A		Subchronic Hepatotoxicity of Selenomethionine
HARVEY, K. D.	HAY, L. E. Effects of Land-Use Buffer Size on Spearman's	Ingestion in Mallard Ducks. W91-10838 5C
Hydrometric Data Collection and Interpretation	Partial Correlations of Land Use and Shallow	
in the Prairie Provinces and Northwest Territo-	Ground-Water Quality. W91-10761 4C	HEINZLE, E. Treatment of Bleaching Effluents In Aerobic/
ries. W91-11278 7A		Anaerobic Fluidized Biofilm Systems.
	Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin.	W91-11486 5D
HASHIMOTO, E. Flow Control Technology for Enhancement and	W91-11060 5C	HELALIA, A. M.
Diverse Use of the Marine Environment.	Simulation of Precipitation by Weather Type	Effect of Low Salinity Water on Salt Displace-
W91-10607 2L	Analysis.	ment in Two Soils. W91-11433 2G
назнімото, у.	W91-11230 2B	
Citizen's Movements to Protect the Environ-	HAYASE, T.	HELMER, R.
ment of Rivers Flowing into the Seto Inland Sea: An Example of a Citizen's Movement	Countermeasures Against Water Pollution in Enclosed Coastal Seas in Japan.	Public Health Criteria for the Aquatic Environ- ment: Recent WHO Guidelines and Their Appli-
Along the Toga River.	W91-10572 5G	cation.
W91-10587 5G	HAYASHITA, T.	W91-10620 5G
HASSAN, M. A.	Selective Concentration of Lead(II) Chloride Complex With Liquid Anion-Exchange Mem-	HEMMINGA, M. A.
Distance of Movement of Coarse Particles in Gravel Bed Streams.	branes.	Balance of Nutrient Losses and Gains in Sea- grass Meadows.
W91-11231 2J	W91-11247 5D	W91-10867 2L
HASSANI, L.	HAYDOCK, I.	HENDRICKS, M. S.
Aeromonas Species Stabilization Ponds in the Arid Region of Marrakesh, Morocco, and Rela-	Coefficient of Pollution (p): The Southern Cali- fornia Shelf and Some Ocean Outfalls. W91-10874 5B	Treatability of Hazardous Chemicals in Soils: Volatile and Semivolatile Organics.
tion to Fecal-Pollution and Climatic Factors. W91-10842 5D		W91-10712 5B
	HAYWARD, A. C. Foaming in Activated Sludge Plants: A Survey	HENDRIKSEN, H. V.
Dynamics of Non-01 Vibrio cholerae in Experi- mental Sewage Stabilization Ponds Under Arid	in Queensland, Australia and an Evaluation of Some Control Strategies.	Anaerobic Degradation of PCP and Phenol In Fixed-Film Reactors: The Influence of an Addi-
Mediterranean Climate. W91-10690 5D	W91-11328 5D	tional Substrate.
	HE, Q.	W91-11512 5D
HATA, Y.  Growth Potentials of Red Tide Phytoplankters	Environmental Assessment of Wastewater Marine Disposal of Xiaogang Zone, Ningbo.	HENNIGAR, P.
in Coastal Seawater by AGP Assay.	W91-10570 5E	Contamination of Ponds by Fenitrothion during Forest Spraying.
W91-10548 5A	HEALEY, T.	W91-11298 5B
HATAKEYAMA, S.	Modern Environmental Assessment Procedures	HENRY, C. L.
Effects of Chlornitrofen, a Herbicide, on Reproduction of Brachionus urceolaris (Rotatoria)	for Enclosed Seas. W91-10564 6G	Nitrogen Dynamics of Pulp and Paper Sludge
Through Water and Food (Chlorella).	HECKMAN, C. W.	Amendment to Forest Soils.
W91-11458 5C	Usefulness of Various Numerical Methods for	W91-11510 5E
HATAKKA, A. I.	Assessing the Specific Effects of Pollution on Aquatic Biota.	HENZE, G.
Onset of Lignin-Modifying Enzymes, Decrease of AOX and Color Removal by White-Rot	W91-11406 5C	Comparison of Amperometric and UV-Spectro- photometric Monitoring in the HPLC Analysis
Fungi Grown on Bleach Plant Effluents.	HEDGES, L. J. Incidence of Legionella in the Urban Environ-	of Pesticides. W91-11306 5A
W91-11487 5D	ment in Australia.	
HATTORI, K. Sea and Fresh Water Conservation.	W91-10929 5B	HERB, W. J.  Minnesota District, Water Resources Division:
W91-10578 5G	HEFNER, J. W.	Information and Technical Assistance.
HAUENSTEIN, J. J.	Dallas' Flood Caverns. W91-10493 8A	W91-11167 2F
Assessment of Agricultural Nutrient Point	HEFTA, M.	HERBOLD-PASCHKE, K.
Source Discharge from Tile Drains, Spring and Overland Runoff from Two Farms, Dauphin	Removal of Biota from Inter-Basin Transfer	Behaviour of Pathogenic Bacteria, Phages and Viruses in Groundwater During Transport and
County, Pennsylvania.	Water. W91-11017 5F	Adsorption.
W91-11600 5B	HEIDMAN, J. A.	W91-10672 5B
HAVELAAR, A. H.	Evaluation of Full Scale Activated Sludge Sys-	Transport of Microorganisms in the Under-
Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems.	tems Utilizing Powdered Activated Carbon Ad- dition with Wet Air Regeneration.	ground: Processes, Experiments and Simulation Models.
W91-10677 5F	W91-11099 5D	W91-10674 5B

HERCZEG, A. L. Salinity and Evaporation in the River Murray	HIGASHI, T. Benthic Faunal Succession in a Cove Organical-	HOBBS, P. V. Research on Clouds and Precipitation: Past,
Basin, Australia. W91-10989 2E	ly Polluted by Fish Farming. W91-10554 5C	Present and Future, Part II. W91-10481 3B
HERLIHY, A. T. Acid-Base Status of Pennsylvania Streams: Re-	HIGGINS, C. G. Piping and Pseudokarst in Drylands.	HOCHREITER, J. J. Geophysical and Chemical Investigations of
sults from the National Stream Survey. W91-10726 5B	W91-11561 2F HIGGINS, R. J.	Ground Water at Five Industrial or Waste-Dis- posal Sites in Logan Township, Gloucester
Stream Chemistry in the Eastern United States:  1. Synoptic Survey Design, Acid-Base Status,	Off-River Storages as Sources and Sinks for Environmental Contaminants. W91-10851 5B	County, New Jersey, 1983-87. W91-11092 5B
and Regional Patterns. W91-11241 5B	HILL, B. M.	HOCK, B.  Development of an Enzyme Immunoassay for
Stream Chemistry in the Eastern United States: 2. Current Sources of Acidity in Acidic and	Fate of Silicate Minerals in a Peat Bog. W91-10789 2H	the Determination of Metazachlor. W91-11295 5A
Low Acid-Neutralizing Capacity Streams. W91-11242 5B	Groundwater Flow and the Metal Content of Peat.	HODGSON, K. M. Application of Supported Liquid Membranes for
HERMANSON, M. H. Polychlorinated Biphenyls in Dated Sediment	W91-10902 2F	Removal of Uranium From Groundwater. W91-11370 5G
Cores from Green Bay and Lake Michigan. W91-10979 5B	HILL, J. P. Comparative Water Management: A Tale of	Fiscal Year 1988 Supported Liquid Membrane
Recent Sedimentation in Lake Michigan.	Two Compacts. W91-11042 6A	Development Report. W91-10727 5G
W91-10976 2J	HILL, M. C.	HODIN, F.
HERNANDEZ, A.  Hydrocarbons in Urban Runoff: Their Contribu- tion to the Wastewaters.	Preconditioned Conjugate-Gradient 2 (PCG2), A Computer Program for Solving Ground- Water Flow Equations.	Formation of Chlorophenols and Related Com- pounds In Natural and Technical Chlorination Processes.
W91-10885 5B	W91-10764 7C	W91-11508 5B
HERNANDEZ, J. F. Miniaturized Fluorogenic Assays for Enumera- tion of E. coli and Enterococci in Marine Water.	HILLAIRE-MARCEL, C. First-Order Organic Carbon Budget in the St	HOEKSTRA, J. A. Production and Control of Reference Materials
W91-10639 5A	Lawrence Lower Estuary from 13C Data. W91-10498 2L	for Water Microbiology. W91-10623 5A
HERRING, A. J.  Growth of Clinical Isolates of Astrovirus in a	HILLER, M. A. National Estuary Program and Public Involve-	HOFFMAN, D. J.
Cell Line and the Preparation of Viral RNA. W91-10669 5A	ment. W91-10590 5G	Subchronic Hepatotoxicity of Selenomethionine Ingestion in Mallard Ducks.
HERRING, J.	HILLS, P.	W91-10838 5C
Iterative Evaluation of a Lake Water Quality Management Program.	Hong Kong: Can the Dragon Clean its Nest. W91-11439 5G	HOFFMAN, J. S.  Challenge of Sustaining Productivity in the Face
W91-10808 5G	HILTLON, J.	of CO2-Induced Change. W91-11073 5C
HERTZBERG, V.  Fertility of Workers Chronically Exposed to	Dynamic Model of Caesium Transport in Lakes and Their Catchments.	HOFFMAN, R. J.
Chemically Contaminated Sewer Wastes. W91-11316 5D	W91-10934 5B	Phosphorus in the Truckee River Between Vista and Patrick, Storey and Washoe Counties,
HERVE, S.	HINLEIN, E. S. Field Sampling of Residual Aviation Gasoline in	Nevada, August 1984. W91-10763 5A
Monitoring of Organochlorine Compounds In Finnish Inland Waters Polluted by Pulp and	Sandy Soil. W91-10795 5A	HOFFMANN, A.
Paper Effluents Using the Mussel Incubation Method.	HIRATA, K.	Biochemical and Histochemical Observations on
W91-11507 5A	Clostridium perfringens, as an Indicator Micro- organism for the Evaluation of the Effect of	Effects of Low-Level Metal Load (Lead, Cad- mium) in Different Organ Systems of the Fresh- water Crayfish, Astacus astacus L. (Crustacea:
HESPANHOL, I.  Public Health Criteria for the Aquatic Environment: Recent WHO Guidelines and Their Appli-	Wastewater and Sludge Treatment Systems. W91-10686 5D	Decapoda). W91-10827 5B
cation.	HIRATA, T. Clostridium perfringens, as an Indicator Micro-	HOGENDOORN, E. A.
W91-10620 5G HESS, A. E.	organism for the Evaluation of the Effect of Wastewater and Sludge Treatment Systems.	
Thermal-Pulse Flowmeter for Measuring Slow Water Velocities in Boreholes.	W91-10686 5D	W91-11308 5A
W91-10766 8G	HIRAYAMA, F. Formation of Oxygen-Deficient Water Mass in	HOGGART, C. R. Simulation of Bioecological and Water Quality
HEWLETT, M. J.  Application of a Poliovirus cDNA Probe for the	Omura Bay. W91-10592 5B	Processes in Enclosed Coastal Seas. W91-10557 50
Detection of Enteroviruses in Water. W91-10667 5A	HISANO, T.	HOLDSWORTH, G.
HEYDRA, G. Rocking Armour Units: Number, Location and	Countermeasures Against Water Pollution in Enclosed Coastal Seas in Japan. W91-10572 5G	Altitude in the Saint Elias Mountains of Canada
Impact Velocity. W91-10786 8A		HOLLER, H.
HEYMAN, W.	Flood-Hazard Zonation in Arid Lands. W91-11390 6F	Squall Line in Southern Germany: Kinematics and Precipitation Formation as Deduced by Ad
Membrane Filtration Combined with Biological Treatment for Purification of Bleach Plant Ef-	но, к. s.	vanced Polarimetric and Doppler Radar Meas
fluents.	Electroosmotic Strengthening of Soft Sensitive	wrements. W91-11420 2E
	W91-10777 8D	
HIEDRA-COBO, J. C. Pressure of Clay Backfill against Retaining		Socio-Economic Impact of Improved Wells in
Structures.	Soft Sensitive Clay.	Rural Sierra Leone. W91-11358

HOLMSTROM, B. K. Effects of the 1988 Drought on Water Resources	HOUSIADAS, C. Spatial Distribution of Rainfall in the Greater	HUSER, L. Experience with Low-Head HydroPlant Fre-
in Wisconsin.	Athens Area.	quency Control.
W91-11108 2E	W91-11416 2B	W91-11214 8C
HOLZHEY, C. S. WEPP: Soil Erodibility Experiments for Range- land and Cropland Soils.	HOUSTON, J. Use of Bacillus thuringiensis var. israelensis to Control the Nuisance Fly Sylvicola fenestralis	HUSTER, R. Closing Paper Mill Whitewater Circuits by In- serting an Anaerobic Stage with Subsequent
W91-10512 2J	(Anisopodidae) in Sewage Filter Beds.	Treatment.
HOOGWEG, P. H. A.	W91-10890 5D	W91-11477 5G
North Sea Strategies. W91-10530 5G	HRUDEY, S. E.	HUTAREW, A.
HOOPER, R. P.	Anaerobic Treatability of a Phenolic Coal Con- version Wastewater After Diisopropyl Ether	Converter Application for Mini Hydro Genera- tion.
Assessing the Response of Emerald Lake, an	Extraction.	W91-11213 8C
Alpine Watershed in Sequoia National Park, California, to Acidification during Snowmelt by	W91-10939 5D	HUTCHINSON, C. B.
Using a Simple Hydrochemical Model.	HUANG, M. Environmental Assessment of Wastewater	Analysis of Ground-Water Flow in the A-Sand
W91-11594 5C	Marine Disposal of Xiaogang Zone, Ningbo.	Aquifer at Paramaribo, Suriname, South Amer- ica.
Executive Summary-Assessing the Response of Emerald Lake, An Alpine Watershed in Sequoia	W91-10570 5E	W91-11090 2F
National Park, California, to Acidification	HUENEFELD, B.	Assessment of Hydrogeologic Conditions with
During Snowmelt Using a Simple Hydrochemi- cal Model.	Long Climb to Remediation. W91-10483 5G	Emphasis on Water Quality and Wastewater Injection, Southwest Sarasota and West Charlotte
W91-11112 7C	HUG, A. W.	Counties, Florida.
HORAN, N. J.	FACTA 1990 Conservation and Environmental	W91-11087 2F
Influence of Reactor Mixing Characteristics on	Highlights. W91-10507 5G	HUTTERMANN, A.
the Rate of Nitrification in the Activated Sludge Process.		Decrease of Pollutant Level of Bleaching Ef-
W91-10932 5D	HUIZAR-ALVAREZ, R. Studies of Springs in the Southern Part of the	fluents and Winning Valuable Products by Suc- cessive Flocculation and Microbial Growth.
HORDON, R. M.	Valley of Mexico (Estudio Crenologico en la	W91-11488 5D
Buffer Strips to Protect Water Supply Reser-	Parte Meridional de la Cuenca de Mexico). W91-11352 2E	HWU, B. L.
voirs: A Model and Recommendations. W91-10816 5G		Behavior of Double Geonet Drainage Systems.
HORN, R.	HUME, J. M. Shifts in Fish Vertical Distribution in Response	W91-11096 5A
ARCHIMEDES IIa Experiment on Oil Slick	to an Internal Seiche in a Stratified Lake.	IBELINGS, B. W.
Detection over the North Sea-April 1988-	W91-10864 2H	Microcystis Changes its Buoyancy in Response to the Average Irradiance in the Surface Mixed
Measurement Results Obtained by the E-SAR System of the German Aerospace Research Es-	HUNN, J.  Bioaccumulation, Elimination and Metabolism of	Layer.
tablishment. W91-10742 5B	Triphenyltin Chloride by Early Life Stages of	W91-10895 2H
	Minnows Phoxinus phoxinus. W91-10877 5B	IDABOR, P.
HORNBERGER, G. M. Throughflow and Solute Transport in an Isolat-		Proximate Composition and Nutrient Elements in the Unusual Algal Jellies of Lake Oguta in
ed Sloping Soil Block in a Forested Catchment.	Phenyltins in Water, Sediment, and Biota of Freshwater Marinas.	Southern Nigeria.
	W91-11342 5B	W91-11408 2H
HORNSBY, A. G. Florida's Pesticide Water Quality Education	HUNT, J. R.	IDEMA, G. K.  Comparison of Methods for the Isolation of a
Program.	Fluidization of Marine Mud by Waves. W91-10533 5B	Wide Range of Viruses from Shellfish.
W91-11202 5G		W91-10698 5A
HORSTMAN, K. New Storm Water Regulations Require Signifi-	HUNT, P. H.  Acoustic Parametric Array for Measuring the	Detection of Rotavirus in South African Waters:
cant Compliance Actions by Both Industries and	Thickness and Stratigraphy of Contaminated	A Comparison of a Cytoimmunolabelling Tech- nique with Commercially Available Immunoas-
Municipalities. W91-11541 5D	Sediments. W91-10981 2J	says.
HORWITZ, E. P.	HUNTER, C.	W91-10660 5A
Application of Supported Liquid Membranes for	Seasonal Changes in the Sanitary Bacterial Qual-	IGAWA, M.
Removal of Uranium From Groundwater. W91-11370 5G	ity of Water Draining a Small Upland Catch- ment in the Yorkshire Dales.	Selective Concentration of Lead(II) Chloride Complex With Liquid Anion-Exchange Mem-
	W91-10935 5B	branes.
Synthesis and Decomposition of Novel Organo- phosphorus Complexants.	HUPP, C. R.	W91-11247 5D
W91-11372 5D	Dendrogeomorphic Approach to Estimating	IHSSEN, P. E.
HOSHIKA, A.	Slope Retreat, Maxey Flats, Kentucky. W91-11395 2D	Chemical and Biological Factors Affecting Acid Tolerance of Smallmouth Bass.
Heavy Metal Pollution in Sediment from the Seto Inland Sea, Japan.		W91-11530 5C
W91-10537 5B	Dendrogeomorphic Approach to Measurement of Sedimentation in a Forested Wetland, Black	IIDA, H.
HOSKINS, W. W.	Swamp, Arkansas.	Meteorology and Oceanography in the Seto Inland Sea.
Environmental Control Impacts of Selected Al-		W91-10520 2L
ternate Fuels on Existing Power Plants. W91-11078 5G	HURLEY, M. A.  Humic Substances in Acid Surface Waters:	IMAI, C.
HOSOMI, M.	Modelling Aluminium Binding, Contribution to	Life Cycle Strategies of the Red Tide Causing
Computer Visualization System for Sediment	Ionic Charge-Balance, and Control of pH. W91-10933 5C	Flagellates Chattonella (Raphidophyceae) in the Seto Inland Sea.
Pollution in Japan. W91-10609 7C		W91-10546 5B
HOTZL, H.	HURWITZ, R. New York City's Delaware River Basin	IMASAKA, K.
Application of Microbial Tracers in Groundwat-	Supply-A Case Study in Interstate Coopera-	Benthic Faunal Succession in a Cove Organical-
er Studies. W91-10671 5E	tion W91-11046 6E	ly Polluted by Fish Farming. W91-10554 5C

Eutrophication Mechanisms of Coastal Seas		SLAM, T. Water Use of a Winter Wheat Cultivar (Triti-	JANKOWSKI, J.
Yamaguchi Prefecture.	ш	cum Aestivum).	Hydrochemistry of a Groundwater-Seawater Mixing Zone, Nauru Island, Central Pacific
	5B	W91-11436 3F	Ocean.
INCULET, I. I.	r	TAKURA, S.	W91-11297 2K
Electroosmotic Strengthening of Soft Sensiti	ive	Life Cycle Strategies of the Red Tide Causing	JANSSON, P. E.
Clays. W91-10777	8D	Flagellates Chattonella (Raphidophyceae) in the Seto Inland Sea.	Modelling Water and Solute Transport in Ma-
		W91-10546 5B	croporous Soil. I. Model Description and Sensi-
Field Test of Electroosmotic Strengthening			tivity Analysis. W91-10803 5B
Soft Sensitive Clay. W91-10778	8D I	TOH, K.  Life Cycle Strategies of the Red Tide Causing	W 91-10003
		Flagellates Chattonella (Raphidophyceae) in the	JANZEN, E. M.
INGRI, J.  Rapid Preconcentration Method for Multie	ole.	Seto Inland Sea.	Coliphage and Bacteriophage as Indicators of Recreational Water Quality.
ment Analysis of Natural Freshwaters.		W91-10546 5B	W91-11334 5A
W91-10892	7B 1	TTLINGER, R.	
INKEROINEN, M. M.		Health Risk Assessment of Water Contaminants	JARDINE, P. M. Hydrogeochemical Processes Controlling Sub-
Onset of Lignin-Modifying Enzymes, Decre		Using Baseline Data of Cancer Incidence in Dif- ferent Water Supply Areas.	surface Transport from an Upper Subcatchment
of AOX and Color Removal by White-I	Rot	W91-10614 5F	of Walker Branch Watershed During Storm
Fungi Grown on Bleach Plant Effluents. W91-11487	5D 1	IVANCHENKO, I. P.	Events. 1. Hydrologic Transport Processes.
		Operating Experience and Suggestions on Re-	W91-10907 5B
INOMATA, Y. Investigation on Turbidity and Flow Patterns	s in	construction of the Turbines of the Dnepr-I Hy-	Hydrogeochemical Processes Controlling Sub-
Half-Closed Sea Area.		droelectric Station. W91-11290 8C	surface Transport from an Upper Subcatchment
W91-10532	5B	W91-11290 8C	of Walker Branch Watershed During Storm Events, 2. Solute Transport Processes.
INOUE, T.	1	IZAWA, H.	W91-10908 5B
Runoff Characteristics of COD, BOD, C, N,		Eutrophication in Hiroshima Bay. W91-10536 5B	IADDETT D D
P Loadings from Rivers to Enclosed Coa Seas.			JARREIT, R. D. Paleohydrologic Techniques Used to Define the
W91-10521	5B '	JACKSON, J.  Assessment of the Salinity Tolerance of Eight	Spatial Occurrence of Floods.
		Sonoran Desert Riparian Trees and Shrubs.	Ŵ91-11396 2E
INOUE, Y. Sea and Fresh Water Conservation.		W91-10752 3C	JARVINEN, K.
W91-10578	5G	JACKSON, P. L.	Oxic Fluidized-Bed Treatment of Dichlorophen-
INTROCASO, D. M.		Managing Oregon's Estuarine Resources Lands.	ols.
Photographs Written Historical and Descrip	tive	W91-10508 2L	W91-11485 5D
Data.	6E	JACOB, J.	JARVINEN, R.
W91-11577	OE	Study of Campylobacter in Sewage, Sewage	Factors Affecting the Removal and Discharge
IQBAL, N.	11	Sludge and in River Water. W91-10634 5D	of Organic Chlorine Compounds at Activated Sludge Treatment Plants.
Studies on the Effects of Some Organic Po- ants on the Heavy Metal Transport in an Inc		W91-10034	W91-11498 5D
Soil.	Cian	JACOBI, C. M.	
W91-11457	5C	Oil Spills in Mangroves: A Conceptual Model Based on Long-term Field Observations.	JARVIS, N. J.
IRBY, R. B.		W91-10489 5B	Modelling Water and Solute Transport in Ma- croporous Soil. I. Model Description and Sensi-
Effects of Copper and Tributyltin on Stress	Pro-	JACOBS, J. L.	tivity Analysis.
tein Abundance in the Rotifer Brachionus p	lica-	Bacterial Water Quality in Urban Receiving	W91-10803 5B
tilis. W91-10900	5C	Waters.	Modelling Water and Solute Transport in Ma-
		W91-10633 5B	croporous Soil. II. Chloride Breakthrough
IRELAND, R. J.  Abbeystead Outfall Works: Background to	Re-	JACOBSON, G.	Under Non-Steady Flow. W91-10804 2G
pairs and Modifications and Lessons Lear		Hydrochemistry of a Groundwater-Seawater	W91-10804 2G
W91-11355	5D	Mixing Zone, Nauru Island, Central Pacific Ocean.	JARVIS, P. G.
IRITZ, L.		W91-11297 2K	Rainfall Interception and Boundary Layer Con-
Dynamic Simulation Model of Vertical Infi	iltra-	JAKOB, J.	ductance in Relation to Tree Spacing. W91-10905 2I
tion of Water in Soil. W91-10968	2A	Aerobic-Thermophilic Methods for Disinfecting	
		and Stabilizing Sludge.	JARZYNA, B.  Coal Mine Waters and Their Influence on the
IRRGANG, G. H. Long Climb to Remediation.		W91-11143 5D	Purity Ecological State of River and the Fish
W91-10483	5G	JAKUBOWSKI, W.	Production.
TRIVIN D		Determining Giardiasis Prevalence by Examina-	W91-10605 5B
IRWIN, B.  Coulometric Measurement of Primary Pro	duc-	tion of Sewage. W91-10646 5A	JEFFER, H.
tion, with Comparison against Disso	olved		Effects of Acid Rain on Epiphytic Orchid
Oxygen and 14-C Methods in a Seasonal Si		Distribution of Giardia Cysts in Wastewater. W91-10649 5B	Growth.
W91-10868	2L		W91-11076 5C
ISHIDA, T.		JAMES, W. F. Estimation of Phosphorus Exchange Between	JEFFERY, J.
Existing Conditions for Agricultural Utiliz of Sewage Sludge Compost in Japan.	ation	Littoral and Pelagic Zones During Nighttime	Cryptosporidiosis and water Supply: A Brief
W91-11152	5E	Convective Circulation.	the Pederock Committee
		W91-10863 2H	W91-11271 5F
ISHIO, S.  Bloom of Coscinodiscus wailesii and DO D	eficit	JAMESON, A. R.	
of Bottom Water in Seto Inland Sea.		Comparison of Microwave Techniques for	<ul> <li>JENKINS, A.</li> <li>Dynamic Model of Caesium Transport in Lakes</li> </ul>
W91-10549	5C	Measuring Rainfall. W91-10499 2B	
ISHIZAKI, Y.		W 71-10499	W91-10934 5B
Construction of Artificial Seaweed Bed Ac	ccom-	JANA, B. B.	JENKINS, E. L.
panied with the Reclamation for Unit No. Ikata Power Station.	. 3 of	Production of Chironomid Larvae in Culturing Media of Various Organic Wastes.	Capillary Column Gas Chromatography With
W91-10603	2L	W91-11526 81	

tion of Nitrogen-and Phosphorus-Containing Pesticides in Finished Drinking Waters: Collabo- rative Study. W91-11259 5A	JOHNSON, R. L. Aquatic Habitat Measurement and Valuation: Imputing Social Benefits to Instream Flow Levels.	JOZIASSE, J.  Removal of Heavy Metals from Sewage Sludge: State of the Art and Perspectives.  W91-11124 5D
	W91-11266 7C	
JENKINS-MCLEAN, T. Lessons Learned from a Third World Water and Sanitation Project.	Shifts in Fish Vertical Distribution in Response to an Internal Seiche in a Stratified Lake.	JUANG, H. M. H. Numerical Simulations of the Evolution of a Cold Front and its Precipitation.
W91-10503 5F	W91-10864 2H	W91-11418 2B
JENNINGS, S. G. Efficiency With Which Drizzle and Precipita- tion Sized Drops Collide With Aerosol Particles. W91-11252 2B	JOKINEN, K. Factors Affecting the Removal and Discharge of Organic Chlorine Compounds at Activated Sludge Treatment Plants. W91-11498 5D	JUDGE, A. S.  Analysis of Ground-Probing Radar Data: Predictive Deconvolution.  W91-10782  8G
JENSEN, K. Review of Interbasin Water Transfers with Specific Attention to Biota. W91-11013 6B	JONES, D. In the Land of the Giants: Grassroots Organiz- ing in California's Central Valley. W91-11205 5G	JULIEN, G. Contamination of Ponds by Fenitrothion during Forest Spraying. W91-11298 5B
JENSEN, O. G.		
Analysis of Ground-Probing Radar Data: Predictive Deconvolution.  W91-10782  8G	JONES, D. M. Latex Agglutination for the Detection of Cam- pylobacter Species in Water. W91-11465 5A	JUNNA, J.  Activated Sludge Treatment of Kraft Mill Effluents from Conventional and Oxygen Bleaching
JEPIFANTSEVA, E. I.	JONES, F.	ing. W91-11511 5D
Thermocatalytic and Chemical Treatment of Lignin-Aluminium Sludge and Utilization of the Resulting Adsorbent-Coagulant.	Results of the First Pilot-Scale Controlled Cohort Epidemiological Investigation into the Possible Health Effects of Bathing in Seawater	Trends In Water Pollution Control In the Finnish Pulp and Paper Industry. W91-11468 5G
W91-11503 5D	at Langland Bay, Swansea. W91-11366 5C	
JIANG, M. Simultaneous Ultraviolet Spectrophotometric Determination of Nitrate and Nitrite in Water.	JONES, G. A.  Comparison of Alternative Operating Modes on the Halifax Activated-Sludge Plant.	JUSTE, C.  Microbial Biomass and Biological Activities in an Acid Sandy Soil Treated with Sewage Sludge or Farmyard Manure in a Long Term Field
W91-10824 5A	W91-11359 5D	Experiment.
JIANRONG, Z.	JONES, H. G.	W91-11160 5E
Factors Affecting the Relationship Between the NBOD Values and the Amounts of Nitrogenous Pollutants: A Field Study on the Lee River. W91-10940 SC	Subice Layering and Origin of Acidic Waters in a Small Boreal Lake During the Spring Runoff. W91-11229 5B	KAEHLER, C. A. Geohydrology and Simulation of Ground-Water Flow in the Mesilla Basin, Dona Ana County,
JICKELLS, D.	JONES, K.	New Mexico, and El Paso County, Texas. W91-11088 2F
Sequential Sampling of Particles, Major Ions and Total Trace Metals in Wet Deposition.	Application of Physicochemical Treatment to an Overloaded Sewage Works. W91-11357 5D	KAHN, N. N.
W91-11249 5B		Studies on the Effects of Some Organic Pollut-
JODICE, R.	JONES, P. D. Precipitation in Britain: An Analysis of Area-	ants on the Heavy Metal Transport in an Indian Soil.
Control of Enteric Micro-organisms by Aerobic- Thermophilic Co-Composting of Wastewater	Average Data Updated to 1989. W91-10973 2B	W91-11457 5C
Sludge and Agro-Industry Sludge. W91-10693 5E	JONGELING, T. H. G. In-Flow Vibrations of Gate Edges.	KAHN, S. Studies on the Effects of Some Organic Pollut-
JOFRE, J.	W91-10724 8B	ants on the Heavy Metal Transport in an Indian Soil.
Concentration of Hepatitis A Virus in Environ-	JONSSON, S.	W91-11457 5C
mental Samples. W91-10658 5A	Organohalogens of Natural and Industrial Origin In Large Recipients of Bleach-Plant Effluents.	KAIN, T.
JOHL, M.	W91-11505 5B	Wetland Impoundments of East-Central Florida. W91-10854 2L
Virological Investigation of the River Elbe. W91-10652 5B	JOP, K. M. Concentration of Metals in Various Larval	KAJAK, A.
JOHNSEN, P. B.	Stages of Four Ephemeroptera Species. W91-11302 5B	Can Fauna Impoverishment Affect Humus Con- tent in Cultivated Soils (Czy ubozenie fauny
Development of an Enzyme-Linked Immunosor-	JORDAN, C.	moze wplywac na zawartosc prochnicy w gle-
bent Assay for Geosmin. W91-10921 5F	Variation in the Acidity of Ground and Surface Waters in Northern Ireland.	bach uprawnych). W91-11543 2G
JOHNSON, B. D.	W91-11407 2H	KALLQVIST, T.
Effect of a Spring Phytoplankton Bloom on	JORET, J. C.	Algicidal and Chemical Effect of u.vRadiation
Dissolved Copper Speciation in Bedford Basin. W91-10543 5B	Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Poten-	of Water Containing Humic Substances. W91-10941 5F
JOHNSON, B. N.	tial Regrowth of Bacteria.	
Hydrometric Data Collection and Interpretation in the Prairie Provinces and Northwest Territo-		KAMIETH, H. Usefulness of Various Numerical Methods for
ries.	JOSHI, R. C. Change in Pore Size Distribution Owing to Sec-	Assessing the Specific Effects of Pollution of Aquatic Biota.
W91-11278 7A	ondary Consolidation of Clays.	W91-11406 50
JOHNSON, K. S.  Determination of Subnanomolar Levels of	W91-10774 8D	KAMPBELL, D. H.
Iron(II) and Total Dissolved Iron in Seawater by Flow Injection Analysis with Chemilumines-	Staphylococci in Polluted Waters and in Waters	Biodegradation of Hydrocarbon Vapors in the Unsaturated Zone.
cence Detection.	W91-10631 5B	W91-11227 5E
W91-10773 2K	JOWITT, P. W.	KAMPE, W.
JOHNSON, R. A.	Maximum Entropy View of Probability-Distrib-	Organic Substances in Soils and Plants afte
Ambient Air Co-Modeling in Alaska. W91-11070 7C	uted Catchment Models. W91-10965 2A	Intensive Applications of Sewage Sludge. W91-11126 51

5E

KANEKAR, P.	KATSIFARAKIS, K.	KENNEDY, E. J.
Activated Sludge Process to Reduce the Pollu- tion Load of a Dye-Industry Waste. W91-11455 5D	Boundary Element and Particle Tracking Model for Advective Transport in Zoned Aquifers. W91-10997 2F	Levels at Streamflow Gaging Stations. W91-11586 7B
KANEKO, M.	KATTELMANN, R.	KENNEDY, K. J.
Clostridium perfringens, as an Indicator Micro- organism for the Evaluation of the Effect of	Exporting Himalayan Floods. W91-11014 2E	Anaerobic Toxicity of Fines In Chemi-thermo- mechanical Pulp Wastewaters: A Batch Assay-
Wastewater and Sludge Treatment Systems. W91-10686 5D	KATZ, L. E.	Reactor Study Comparison. W91-11479 5D
	Sorption Phenomena in Subsurface Systems:	
Improvement of the Zeta-Plus Filter Method for Concentration of Viruses from Water. W91-10655 5A	Concepts, Models, and Effects on Contaminant Fate and Transport.	Effect of a Chelating Agent (DTPA) on Anaero- bic Wastewater Treatment in an Upflow Sludge
W91-10033 3A	W91-10882 5B	Blanket Filter.
KANG, S. W.	KAUFMANN, P. R.	W91-11277 5D
Circulation and Pollutant Dispersion in Masan- Jinhae Bay of Korea.	Acid-Base Status of Pennsylvania Streams: Re-	KERKMANN, M. L.
W91-10526 5B	sults from the National Stream Survey. W91-10726 5B	Virological Investigation of the River Elbe.
KAPOOR, R. C.		W91-10652 5B
Comparative Physico-Chemical Analysis of	Stream Chemistry in the Eastern United States: 1. Synoptic Survey Design, Acid-Base Status,	KERNODLE, J. M.
Drinking, Ground and Industrial Waste Water	and Regional Patterns.	Hydrogeology of the Point Lookout Sandstone
of Jodhpur. W91-11083 5B	W91-11241 5B	in the San Juan Structural Basin, New Mexico,
	Stream Chemistry in the Eastern United States:	Colorado, Arizona, and Utah. W91-11114 2F
Estimation of Trace Metals Levels in Power and	2. Current Sources of Acidity in Acidic and	W91-11114 2F
Industrial Waste Water of Jodhpur by Differen- tial Pulse Anodic Stripping Voltammetry.	Low Acid-Neutralizing Capacity Streams.	KESTER, D. R.
W91-11084 5A	W91-11242 5B	Measurement of the Different Forms of Zinc in
KAPPMEYER, J. C.	KAUSHIK, N. K.	Narragansett Bay Water Based on the Rate of Uptake by a Chelating Resin.
Cone Penetrometer Tests and HydroPunch	Impact of a Pulse Application of Permethrin on	W91-10926 2K
Sampling: A Screening Technique for Plume	the Macroinvertebrate Community of a Head- water Stream.	
Definition. W91-10794 5A	W91-11456 5C	Voltammetric Determination of the Complexa- tion Parameters of Zinc in Marine and Estuarine
	KAWAL A.	Waters.
KARLSSON, M. Determination of Trace Levels of Sulphate in	Summary of Ports and Marine Environment Im-	W91-10924 2K
Water Using Flow-Injection and In-Line Pre-	provement Work and Example of Latest Meas-	
concentration.	ures in Seto Inland Sea. W91-10545 5G	KETRATANAKUL, A.  Comparative Study on Adsorption Mechanisms
W91-11246 2K	W91-10343	of RNA-P-Specific Coliphages and Poliovirus in
KARLSSON, S.	KAWAMURA, K.	Activated Sludge Process.
Formation of Chlorophenols and Related Com-	Clostridium perfringens, as an Indicator Micro- organism for the Evaluation of the Effect of	W91-10694 5D
pounds In Natural and Technical Chlorination Processes.	Wastewater and Sludge Treatment Systems.	KFIR, R.
W91-11508 5B	W91-10686 5D	Comparison of Methods for the Isolation of a
Organohalogens of Natural and Industrial Origin	KAWANA, K.	Wide Range of Viruses from Shellfish.
In Large Recipients of Bleach-Plant Effluents.	Heavy Metal Pollution in Sediment from the	W91-10698 5A
W91-11505 5B	Seto Inland Sea, Japan. W91-10537 5B	Detection of Rotavirus in South African Waters:
KARPISCAK, M. M.	W91-10537 5B	A Comparison of a Cytoimmunolabelling Tech-
Residential Water Conservation: Casa Del Agua.	KAY, D.	nique with Commercially Available Immunoas-
W91-10814 3D	Results of the First Pilot-Scale Controlled Cohort Epidemiological Investigation into the	says. W91-10660 5A
KARST, M.	Possible Health Effects of Bathing in Seawater	
Difficulty of Using Coliphages as 'Indicators' and 'Index' Organisms.	at Langland Bay, Swansea.	Microbiological Methods for Safety Testing of
W91-10661 5A	W91-11366 5C	Drinking Water Directly Reclaimed from Wastewater.
KARSTEN, J. W.	KEARL, P. M.	W91-10613 5A
Fluctuating Water Levels in the Great Lakes-St.	Utility of Multiple-Completion Monitoring	
Lawrence River Basin: An Evaluation Frame-	Wells for Describing a Solvent Plume. W91-10800 7A	Most Probable Number Method for the Enu- meration of Legionella Bacteria in Water.
work for the Analysis of Potential Actions. W91-11026 6B		W91-10640 5A
	KEEFER, D. A.  Potential for Aquifer Recharge in Illinois (Ap-	
KASS, W.  Application of Microbial Tracers in Groundwat-	propriate Recharge Areas).	Occurrence of Legionella Bacteria in Cooling Towers in South Africa.
er Studies.	W91-11580 7C	W91-10641 5B
W91-10671 5B	KELLEY, R.	
Field Experiments with Microbiological Tracers	Funding Groundwater Protection Programs:	Occurrence of Male-Specific and Somatic Bac-
in a Pore Aquifer.	Iowa's Groundwater Protection Fund. W91-11179 5G	teriophages in Polluted South African Waters W91-10662 5E
W91-10673 5B		
KATAYAMA, T.	KELLOW, R. L.	KHALEEL, R.
Regional-Wide Waste Disposal Project on Sea-	Interprovincial Water Management in Western Canada.	Evaluation of Analytical Solutions to Estimate Drawdowns and Stream Depletions by Wells
coast of Enclosed Coastal Sea. W91-10594 5E	W91-11040 6E	W91-11240 2F
	KELLY, J. M.	
KATOPODIS, C. Hydraulics of Culvert Fishways IV: Spoiler	Ozone, Acidic Precipitation, and Soil Mg Ef-	KHANGAROT, B. S.  Toxicity of Metals to a Freshwater Tubificid
Baffle Culvert Fishways.	fects on Growth and Nutrition of Loblolly Pine	Worm, Tubifex tubifex (Muller).
W91-11279 8I	Seedlings. W91-10918 5C	W91-11303 3C
KATSAROS, K. B.		KUDICANOV N I
Satellite-Derived Integrated Water-Vapor Dis-	KENDRA, W.  Ouality of Salmonid Hatchery Effluents During	KHRISANOV, N. I.  First Steps Toward Increasing the Reliability of
tribution in Oceanic Midlatitude Storms: Varia- tion with Region and Season.	a Summer Low-Flow Season.	Hydropower and Water-Management Facilities
W91-11419 2B	W91-11532 5D	W91-11291 8A

8A

KIDO, K. Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan. W91-10550 5G	KLING, G. W. Role of Seasonal Turnover in Lake Alkalinity Dynamics. W91-10861 2H	KONDAIAH, K. Standard Test Fish for India and the Neighbor- ing Countries. W91-11300 5A
KIDO, Y. Personal Computer System Supporting Water	KLOPP, R. A. Impact of Recharge Through Residual Oil Upon	KONO, M. Water Control Systems and the Traditional Fes-
Quality Management in Eutrophicated Bay. W91-10582 5G	Sampling of Underlying Ground Water. W91-10793 5B	tival at Miyawaki, on the Seto Inland Sea. W91-10591 3F
KIELY, P. V. Slurry and Sludge Spreading Methods. W91-11161 5E KIKUCHI, T.	KLOSS, K.  Geographical and Pollenanalytical Research of Lake Kleiner Barsch-See (Bez. Potsdam, GDR) (Geographische und Pollenanalytische Untersu-	KONRADSDOTTIR, M.  Removal of Acetate from NSSC Sulphite Pulp Mill Condensates Using Thermophilic Bacteria. W91-10889
Benthic Faunal Succession in a Cove Organical- ly Polluted by Fish Farming. W91-10554 5C	chungen des Kleinen Barsch-Sees) (Bez. Pots- dam, DDR). W91-11514 2H	KOPECKA, H. Detection of Hepatitis A Virus and Other Enter-
KIM, I. S. Determination of Chlorinated Phenoxy Acid	KLUESNER, S. P. Statistical Summaries of Selected Iowa Stream- flow Data Through September 30, 1988.	oviruses in Wastewater and Surface Water Sam- ples by Gene Probe Assay. W91-10665 5A
and Ester Herbicides in Soil and Water by Liquid Chromatography Particle Beam Mass Spectrometry and Ultraviolet Absorption Spec-	W91-10770 2E KNIGHT, I. T.	KORTE, N. E.
trophotometry. W91-10893 5A	Direct Detection of Enteropathogenic Bacteria in Estuarine Water Using Nucleic Acid Probes. W91-10664 5A	Utility of Multiple-Completion Monitoring Wells for Describing a Solvent Plume. W91-10800 7A
KIMOR, B.	KNIGHT, P. G.	KORTEKAAS, S.
Changes and Stress Signs in Plankton Communi- ties as a Result of Man-Induced Perturbations in Enclosed Coastal Seas (Mediterranean, Baltic). W91-10547	Periodic Drainage of Ice-Dammed Lakes as a Result of Variations in Glacier Velocity. W91-11348 2C	Anaerobic Biodegradability and Methanogenic Toxicity of Pulping Wastewaters. W91-11480 5D
	KNITTEL, R.	
KINDZIERSKI, W. B.  Anaerobic Treatability of a Phenolic Coal Conversion Wastewater After Diisopropyl Ether	Effects of Drought Stress and Simulated Acidic Rain on Foliar Conductance of Zea mays L. W91-10919 5C	KORTH, W.  New Standards for the Determination of Geosmin and Methylisoborneol in Water by Gas
Extraction. W91-10939 5D	KNOCHEL, S.	Chromatography/Mass Spectroscopy. W91-11329 5A
KINGSMILL, D. E.	Chlorine Resistance of Motile Aeromonas spp.	
Kinematic, Dynamic, and Thermodynamic	W91-10678 5F	KORZENIEWSKI, K.  Heavy Metals Contamination in the Polish Zone
Analysis of a Weakly Sheared Severe Thunder- storm over Northern Alabama. W91-11417 2B	KNUUTINEN, J. S. High-Performance Liquid Chromatographic	of Southern Baltic. W91-10597 5B
	Study on Oxidation Products of Lignin and Humic Substances.	KOSSON, D. S.
KINSMAN, R.  Microcystis Changes its Buoyancy in Response to the Average Irradiance in the Surface Mixed	W91-11513 5A KOBAYASHI, E.	Migration and Treatment of a Dense Aqueous Contaminant Source and Plume.
Layer. W91-10895 2H	Environmental Management of the Seto Inland Sea.	W91-11380 5G
KIRK, G. J. D.	W91-10573 5G	KOSTKA, J.  Iodine Chemistry in the Water Column of the
Model of Ammonia Volatilization From Applied Urea. V. The Effects of Steady-State Drainage	KOBAYASHI, N. Marine Pollution Bioassay by Using Sea Urchin	Chesapeake Bay: Evidence for Organic Iodine Forms.
and Evaporation. W91-10805 3F	Eggs in the Tanabe Bay, Wakayama Prefecture, Japan, 1970-1987.	W91-10496 2L KOTEL'NIKOV, V. A.
Model of Ammonia Volatilization From Applied Urea. VI. The Effects of Transient-State Water	W91-10602 5A KOENINGS, J. P.	Selection of the Operating Regime of the Onega- Svir' Water System Under Conditions of In-
Evaporation. W91-10806 3F	Secchi Disk and Photometer Estimates of Light Regimes in Alaskan Lakes: Effects of Yellow Color and Turbidity.	creasing Water Consumption. W91-11288 6D
KIRKPATRICK, N. Biological Bleaching of Wood PulpsA Viable	W91-10860 2H	KOTLYAKOV, V. M.
Chlorine-Free Bleaching Technology. W91-11476 5G	KOERNER, R. M. Behavior of Double Geonet Drainage Systems.	Aral Sea Basin: A Critical Environmental Zone. W91-11441 6G
KISHAN, J.	W91-11096 5A	KOTSANIS, N.
Comparative Physico-Chemical Analysis of Drinking, Ground and Industrial Waste Water of Jodhpur.	KOHL, K. D. WEPP: Soil Erodibility Experiments for Range- land and Cropland Soils.	Enhancement of Hepatocarcinogenesis in Rain- bow Trout with Carbon Tetrachloride. W91-11301 5C
W91-11083 5B	W91-10512 2J	
KITAMURA, K.	KOHLBECK, F.	KOTT, Y.  Survival of Pathogenic Bacteria in an Adverse
Environmental Information Processing of Closed Bay Area by Remote Sensing. W91-10581 7B	Method to Determine the Formation Constants of Leaky Aquifers, and Its Application to Pump- ing Test Data.	Environment. W91-10692 5D
KLEPAC, J.	W91-10961 7C	KOTTURI, M. S.
Use of Ligand-Modified Micellar-Enhanced Ul- trafiltration in the Selective Removal of Metal	KOLKMAN, P. Investigation of Local Scour in Cohesionless	Chemical Composition of Individual Storms as a Function of Air Parcel Trajectories for the Pre- diction of Acid Rain Characteristics.
Ions from Water. W91-11318 5D	Sediments Using a Tunnel-Model. W91-10746 2J	W91-11075 5B
KLESIUS, P. H. Development of an Enzyme-Linked Immunosor- bent Assay for Geosmin.	KOMODA, N.  Nongovernmental Educational Activities for Environmental Protection.	KOVALICK, W. M. Satellite-Derived Reflectance of Snow-Covered Surfaces in Northern Minnesota.
W91-10921 5F	W91-10588 5G	W91-11353 7C

KOWALCZYK, C.	KRISTJANSSON, J. K.	(Albizzia lebbek Benth.) on the Growth of Eich-
Coal Mine Waters and Their Influence on the	Removal of Acetate from NSSC Sulphite Pulp	hornia crassipes (Mart.) Solms.
Purity Ecological State of River and the Fish Production.	Mill Condensates Using Thermophilic Bacteria. W91-10889 5D	W91-11449 2I
W91-10605 5B		KUT, O. M.
	KROHN, J.	Treatment of Bleaching Effluents In Aerobic/
KOZHEVNIKOV, N. N. Intake Devices for Dredges with Submersible	Pollutant Transport Monitoring and Prediction by Mathematical Modelling: North Sea and Ad-	Anaerobic Fluidized Biofilm Systems.
Suction Pumps.	jacent Estuaries.	W91-11486 5D
W91-11287 8C	W91-10600 5B	KWIATKOWSKI, T. P.
KOZLOFF, K.	KROMM, D. E.	Dallas' Flood Caverns.
Micro-Targeting Cropland Retirement for	Adoption of Water-Savings Practices by Irriga-	W91-10493 8A
Water Quality Improvement: Measuring the	tors in the High Plains.	KYLE, M. A.
Benefits of Increased Information.	W91-10821 3F	Managing Toxic Substances in Municipal
W91-11052 3F	KROUSE, H. R.	Wastewater Treatment Plants.
KOZLOWSKI, E.	Variation of the Stable Isotopes of Water with	W91-11540 5D
Continuous Flow Thin-Layer Headspace	Altitude in the Saint Elias Mountains of Canada. W91-11220	KZONSKI, J.
(TLHS) Analysis. I. Conductometric Determi- nation of Volatile Organic Halogens (VOX) in		Geophysical and Chemical Investigations of
Tap Water.	KRUIZE, R. R. Sludge Treatment in Amsterdam: Economical,	Ground Water at Five Industrial or Waste-Dis- posal Sites in Logan Township, Gloucester
W91-11256 5A	Technical and Environmental Experiences.	County, New Jersey, 1983-87.
KRAJEWSKI, W. F.	W91-11132 5D	W91-11092 5B
Estimation of the Mean Field Bias of Radar	KRUPICKA, R.	TARTICIPA DA
Rainfall Estimates.	Strategies for Nonprofit Organizations for Pre-	LABUSKES, B. A. Toxics Reduction: The Legal Framework.
W91-10857 2B	venting Agrichemical Contamination of Ground	W91-11538 6E
KRAMER, U.	Water.	
Virological Investigation of the River Elbe.	W91-11204 5G	LACERDA, W. A.
W91-10652 5B	KUBESH, R. J.	Analysis of a Sanitary-Embankment Failure Over the Rio de Janeiro Soft Clay Deposit.
KRAUSE, F.	Laboratory Measurements of Small Raindrop	W91-10780 8D
Decrease of Pollutant Level of Bleaching Ef-	Distortion. Part I: Axis Ratios and Fall Behav- ior.	
fluents and Winning Valuable Products by Suc-	W91-10513 2B	LACOMBE, E. H.
cessive Flocculation and Microbial Growth. W91-11488 5D	VICINIENT I C	Radon in Homes Following Its Reduction in a Community Water Supply.
W 21-11400	KUCHMENT, L. S.  Dynamic-Stochastic Models of Rainfall and	W91-11464 5B
KRAUSE, R. A.	Snowmelt Runoff Formation.	
Crop Data Management Systems, Inc. Meeting California's Pesticide Regulation Challenge.	W91-10967 2A	LACOMBE, P. J.
W91-11177 5G	KUCKLICK, J. R.	Geophysical and Chemical Investigations of Ground Water at Five Industrial or Waste-Dis-
	Natural Phosphate Source for Lake Waccamaw,	posal Sites in Logan Township, Gloucester
KREJMAS, B. E. Report of the River Master of the Delaware	North Carolina, USA.	County, New Jersey, 1983-87.
River, for the Period December 1, 1988-Novem-	W91-11405 2H	W91-11092 5B
ber 30, 1989.	KUKKONEN, J.	LADLIE, J. A.
W91-10765 4A	Bioavailability of Organic Pollutants in Boreal	Professionalism in Agriculture: Seeking a Train-
KRETININA, T. A.	Waters with Varying Levels of Dissolved Or- ganic Material.	ing Standard.
Effect of Long-Term Application of Fertilizers	W91-10936 5B	W91-11198 5G
on the Agrophysical Properties of an Irrigated Light-Chestnut Soil.	KUKLA, G.	LAFLECHE, P. T.
W91-10914 2G	Cloud/Cryosphere Interactions.	Analysis of Ground-Probing Radar Data: Pre-
	W91-11095 2B	dictive Deconvolution. W91-10782 8G
KRETSCHMER, M. Biochemical and Histochemical Observations on	KULAKOV, A. E.	W91-10/82
Effects of Low-Level Metal Load (Lead, Cad-	Intake Devices for Dredges with Submersible	LAFLEN, J. M.
mium) in Different Organ Systems of the Fresh-	Suction Pumps.	WEPP: A New Generation of Erosion Predic-
water Crayfish, Astacus astacus L. (Crustacea:	W91-11287 8C	tion Technology. W91-10511 2J
Decapoda). W91-10827 5B	KULSHRESHTHA, S. N.	
	Implications of Full-Cost Recovery Water Rates	WEPP: Soil Erodibility Experiments for Range-
KREUTZWEISER, D. P.	on Irrigated Farms in Saskatchewan. W91-11054 6C	land and Cropland Soils. W91-10512 2J
Impact of a Pulse Application of Permethrin on the Macroinvertebrate Community of a Head-		
water Stream.	KUNIANSKY, E. L. Maps of the '400-foot,' '600-foot,' and Adjacent	LAGERGREN, S.
W91-11456 5C	Aquifers and Confining Beds, Baton Rouge	Trends in Pollution Control In the Swedish Pulp
KREY, L.	Area, Louisiana.	and Paper Industry. W91-11469 5G
Chemical Composition of Late- and Post-Glacial	W91-11086 2F	
Sediments (Fe, Mn, P, C, N, N, H and BSi) in	KURFURST, P. J.	LAKHWALA, F.
Lake Kleiner Barsch-See, a Bog Lake in the North of GDR (Die Chemische Zusammenset-	Engineering Geology of Nearshore Areas off	Biodegradation of Benzene and a BTX Mixture Using Immobilized Activated Sludge.
zung der Spat- und Postglazialsedimente des	Richards Island, N.W.T.: A Comparison of Stable and Actively Eroding Coastlines.	W91-11381 5D
Kleinen Barsch-Sees (Fe, Mn, P, C, N, H und	W91-10944 2J	
BSi), eines Dystrophen Moorweihers im Norden		LALL, U.  Groundwater Management Model for Salt Lake
der DDR). W91-11518 2H	KUROSAWA, T. Selective Concentration of Lead(II) Chloride	County, Utah with Some Water Rights and
	Complex With Liquid Anion-Exchange Mem-	Water Quality Considerations.
Geographical and Pollenanalytical Research of	branes.	W91-10911 4B
Lake Kleiner Barsch-See (Bez. Potsdam, GDR) (Geographische und Pollenanalytische Untersu-	W91-11247 5D	LAMB, B. L.
chungen des Kleinen Barsch-Sees) (Bez. Pots-	KUSHARI, D. P.	Negotiation Techniques to Resolve Western
dam, DDR).	Influence of Leaf Leachate-Enriched Water of	Water Disputes.
W91-11514 2H	Neem (Azadirachta indica A. Juss.) and Shirish	W91-10817 6E

LAMMI, R. Activated Sludge Treatment of Kraft Mill Ef-	LAW, A. G. Status of Ground Water in the 1100 Area.	Treatment of Waste Water From Wet Lime(Stone) Flue Gas Desulfurization Plants
fluents from Conventional and Oxygen Bleach- ing.	W91-10732 5B LAW. M. N.	With Aid of Crossflow Microfiltration. W91-11371 5D
W91-11511 5D LAMPERT, W,	Provincial Guidelines to Great Lakes Shoreline Management Plans.	LEFEVRE, J. R.
Alternating Dynamics of Rotifers and Daphnia magna in a Shallow Lake.	W91-Ĭ1024 6E	Impact of Coastal Development on the Infralit- toral Zone Along the Southeastern Mediterrane-
W91-10898 2H	LAWRENCE, P. A.  Effect of Land Development on Groundwater	an Shore of Continental France. W91-10562 6G
LANA, P. C. Seasonal Variation of Biomass and Production	Recharge Determined from Non-Steady Chlo- ride Profiles.	LEGLER, J.
Dynamics for Above and Belowground Compo- nents of a Spartina alterniflora Marsh in the	W91-10991 4C LAZERTE, B. D.	Analysis of 10 Selected Herbicides in Water. W91-11311 5A
Euhaline Sector of Paranagua Bay (SE Brazil). W91-10495 2L	Streamflow Generation in a Headwater Basin on the Precambrian Shield.	LEHMANN, R.
LANE, L. J.	W91-11349 2E	Properties of Linear Programming Models for Acid Rain Abatement.
WEPP: A New Generation of Erosion Predic- tion Technology.	LE CORRE, K. Efficiency of an Ozoflotation-Filtration Process	W91-10477 5G
W91-10511 2J LANFEAR, K. J.	for the Treatment of the River Thames at Walton Works.	Uncertainty Analysis for a Linear Programming Model for Acid Rain Abatement.
Fast Algorithm for Automatically Computing	W91-11268 5F	W91-10470 7C
Strahler Stream Order. W91-10818 2J	LEACH, L. E.	LEHR, J. H.
	Field Sampling of Residual Aviation Gasoline in Sandy Soil.	Ground Water: How Contaminated.
Methodology to Derive Water-Quality Trends for Use by the National Water Summary Pro-	W91-10795 5A	W91-10484 5G
gram of the U.S. Geological Survey. W91-11110 7B	LEARNER, M. A. Use of Bacillus thuringiensis var. israelensis to	LEITCH, J. A.  Review of Interbasin Water Transfers with Spe-
LANGDON, A. G.	Control the Nuisance Fly Sylvicola fenestralis (Anisopodidae) in Sewage Filter Beds.	cific Attention to Biota.
Treatability of Bleached Kraft Pulp and Paper	W91-10890 5D	W91-11013 6B
Mill Wastewaters In a New Zealand Aerated Lagoon Treatment System.	LECAPTAIN, L. J.	LELIEVELD, J.
W91-11499 5D	Subchronic Hepatotoxicity of Selenomethionine Ingestion in Mallard Ducks.	Zonal Average Cloud Characteristics for Global Atmospheric Chemistry Modelling.
LANGELAND, G.	W91-10838 5C	W91-10728 2B
Aerobic Thermophilic Digestion of Pre-Thick- ened Sludge Using Air.	LEDGER, D. C.	LEMASTERS, G. K.
W91-10704 5D	Rainfall Interception and Boundary Layer Con- ductance in Relation to Tree Spacing.	Fertility of Workers Chronically Exposed to
LANKINEN, V. P.	W91-10905 2I	Chemically Contaminated Sewer Wastes. W91-11316 5D
Onset of Lignin-Modifying Enzymes, Decrease of AOX and Color Removal by White-Rot	LEE, D. H.	
Fungi Grown on Bleach Plant Effluents. W91-11487 5D	Self-Affine Scaling and Subsurface Response to Snowmelt in Steep Terrain. W91-10912 2G	LEMONE, M. A.  Convective Cell in a Hurricane Rainband.  W91-11422 2B
LARSEN, G.		
Great Lakes Levels and Flows Under Natural and Current Conditions.	LEE, K. Aqueous Photolysis of Napropamide.	LEONI, L.  Trace Element Distribution in Surficial Sedi-
W91-11022 2H	W91-11376 5B	ments of the Northern Tyrrhenian Sea: Contri-
LARSEN, S.	LEE, K. M. Analysis of Three-Dimensional Ground Move-	bution to Heavy-Metal Pollution Assessment. W91-11444 5A
Anaerobic Degradation of PCP and Phenol In Fixed-Film Reactors: The Influence of an Addi-	ments: The Thunder Bay Tunnel.	
tional Substrate.	W91-10775 8A	LEONTARITIS, J. A.  Sewage Treatment and Disposal Strategies in
W91-11512 5D	LEE, R. G. Evaluating Aeration Technology for Radon Re-	Greece. W91-10598 5G
LARSON, K. P. Case Studies in Data Analysis.	moval. W91-11462 5F	
W91-10733 2B		LEPORE, J. V.  Migration and Treatment of a Dense Aqueous
LATINOPOULOS, P. Boundary Element and Particle Tracking Model	LEE, T. C. Delineation of a Discontinuous Aquitard with	Contaminant Source and Plume.
for Advective Transport in Zoned Aquifers.	Vertical Electrical Soundings, San Bernardino Valley, Southern California.	W91-11380 5G
W91-10997 2F	W91-10960 5B	LEPPAKOSKI, E. J.
LAURINO, C. N. Denitrification by Thermophilic Soil Bacteria	LEE, T. R.	Introduced Species-Resource or Threat in Brackish-Water Seas: Examples from the Baltic
With Ethanol as Substrate in a USB Reactor. W91-11254 5D	Managing Water Resources in Latin America. W91-11385 6B	and Black Sea. W91-10552 2L
LAVALLEE, J. G.	LEENHEER, J. A.	
September 5, 1987, Landslide on the La Grande	Use of a Single-Bowl Continuous-Flow Centri- fuge for Dewatering Suspended Sediments:	LESCHBER, R.  Physical and Chemical Characterization of
River, James Bay, Quebec, Canada. W91-10946 2J	Effect on Sediment Physical and Chemical	Sewage Sludge.
	Characteristics. W91-11350 7B	W91-11117 5D
LAVERY, P. S.  Macroalgal-Sediment Nutrient Interactions and	LEFEBVRE, G.	LESHT, B. M. Great Lakes Total Phosphorus Model: Post
Their Importance to Macroalgal Nutrition in a	September 5, 1987, Landslide on the La Grande	Audit and Regionalized Sensitivity Analysis.
Eutrophic Estuary. W91-10497 2L	River, James Bay, Quebec, Canada. W91-10946 2J	W91-10974 2H
LAVOIR, L.	LEFERS, J. B.	LESNE, J.
Effect of NSSC Spent Liquor on Granule For- mation and Specific Microbial Activities In	Investigations With Electrodialysis Reversal for the Treatment of Surface Water to Make-Up	Aeromonas Species Stabilization Ponds in the Arid Region of Marrakesh, Morocco, and Rela-
Upflow Anaerobic Reactors.	Water.	tion to Fecal-Pollution and Climatic Factors.
W91-11482 5D	W91-11368 5F	W91-10842 5D

Dynamics of Non-01 Vibrio cholerae in Experi-	posal Sites in Logan Township, Gloucester	LIN, N. H.
mental Sewage Stabilization Ponds Under Arid Mediterranean Climate.	County, New Jersey, 1983-87. W91-11092 5B	Interannual Variability in Acidic Deposition on
W91-10690 5D	W 91-11092	the Mt. Mitchell Area Forest. W91-10478 5B
	LEWIS, R. J.	W71-10476
LESSARD, P.	Dioxin Contamination and Growth and Devel-	LIN, Y. C.
Dynamic Simulation of Storm Tanks. W91-10928 5D	opment in Great Blue Heron Embryos. W91-10837 5C	Groundwater Management Model for Salt Lake
W 71-10920	W91-10837	County, Utah with Some Water Rights and
LESSER, J. A.	LEZINE, A. M.	Water Quality Considerations. W91-10911 4B
Resale of the Columbia River Treaty Down-	Correlated Oceanic and Continental Records	W 91-10911 4D
stream Power Benefits: One Road from Here to There.	Demonstrate Past Climate and Hydrology of	LINDQVIST, R.
W91-11386 6E	North Africa (0-140 ka). W91-10788 2B	Dispersal Dynamics of Groundwater Bacteria.
	W91-10/86 2B	W91-10843 5B
LETTENMAIER, D. P.	LI, D.	LINERES, I.
Interpretation of Hydrologic Effects of Climate Change in the Sacramento-San Joaquin River	Correction Coefficients for Uniform Channel	Microbial Biomass and Biological Activities in
Basin, California.	Flow. W91-11282 2E	an Acid Sandy Soil Treated with Sewage Sludge
W91-11552 5C	W91-11282 2E	or Farmyard Manure in a Long Term Field
	LI, R.	Experiment.
LETTINGA, G.	Health Risk Assessment of Toluene in California	W91-11160 5E
Anaerobic Biodegradability and Methanogenic Toxicity of Pulping Wastewaters.	Drinking Water.	LINGMIN, F.
W91-11480 5D	W91-10741 5C	Seismic Fracture Analysis of Concrete Gravity
	LIAN, Y.	Dams.
Biotechnological Sulphide Removal from Ef-	Environmental Isotope Study for Estimating	W91-10787 8F
fluents. W91-11502 5D	Leakage and Runoff of Ground Waters in the	LINNEROOTH, J.
W91-11302	Xi'an Area.	Danube River Basin: Negotiating Settlements to
Future Perspectives for the Anaerobic Treat-	W91-10994 2F	Transboundary Environmental Issues.
ment of Forest Industry Wastewaters.	LIAO, X.	W91-11387 5G
W91-11478 5D	Environmental Assessment of Wastewater	TRIO CREATA A R
Thermophilic Anaerobic Treatment of Sulfate-	Marine Disposal of Xiaogang Zone, Ningbo.	LINO GRIMA, A. P. Great Lakes Water Levels Management: Relax-
Rich Pulp and Paper Integrate Process Water.	W91-10570 5E	ing the 'Policy Trap'.
W91-11483 5D	LICHATOWICH, J. A.	W91-11027 6A
Treatment and Detoxification of Aqueous	Pacific Salmon at the Crossroads: Stocks at Risk	
Spruce Bark Extracts by Aspergillus niger.	from California, Oregon, Idaho, and Washing-	LIPIATOU, E.
W91-11481 5D	ton.	Fluxes and Transport of Anthropogenic and
	W91-10834 8I	Natural Polycyclic Aromatic Hydrocarbons in
LEUSCHNER, C.	LICHTENTHALER, R. G.	the Western Mediterranean Sea. W91-10841 5B
Microclimatological Investigations in the Tropi- cal Alpine Scrub of Maui, Hawaii: Evidence for	Biotechnology Degradation and Mitigation of	W 31-10041
a Drought-Induced Alpine Timberline.	Offshore Oil Spills, Phase 1. Main Report: Tech-	LITTLE, E. E.
W91-10878 2I	nology to Enhance Biodegradation of Oil Spills	Sensitivity of Greenback Cutthroat Trout to
	State of the Art and Perspectives for Technolo-	Acidic pH and Elevated Aluminum. W91-11531 5C
LEVER, M. L.	gy Development.	W91-11531 5C
Design of Sewage-Treatment Plants in Brisbane, Australia.	W91-10735 5G	LITTLEJOHN, J. W.
W91-11361 5D	LIETZKE, D. A.	Sheep-Dips as a Source of Pollution of Fresh-
	Hydrogeochemical Processes Controlling Sub-	waters: A Study in Grampian Region.
LEVI, Y.	surface Transport from an Upper Subcatchment	W91-11356 5B
Biodegradable Dissolved Organic Carbon (BDOC) Content of Drinking Water and Poten-	of Walker Branch Watershed During Storm	LIU, C.
tial Regrowth of Bacteria.	Events. 1. Hydrologic Transport Processes. W91-10907 5B	Studies on the Situation of Pollution and Coun-
W91-10630 5F	W91-10907 5B	termeasures of Control of the Oceanic Environ-
TEMPLOS C D	LIGHTFOOT, N. F.	ment in Zhoushan Fishing Ground: The Largest
LEVINGS, C. D. Strategies for Restoring and Developing Fish	Preliminary Statistical Assessment of UK Water	Fishing Ground in China. W91-10559 5C
Habitats in the Strait of Georgia: Puget Sound	Quality Control Trials.	W91-10559 5C
Inland Sea, Northeast Pacific Ocean.	W91-10624 5G	LIU, J. K.
W91-10568 5G	LIKENS, G. E.	Role of Phosphorus Cycling in Algal Metabo-
LEVINGS, G. W.	Impact of Changing Regional Emissions on Pre-	lism and Algal Succession in Lake Donghu,
Hydrogeology of the Point Lookout Sandstone	cipitation Chemistry in the Eastern United	China.
in the San Juan Structural Basin, New Mexico,	States.	W91-10897 5C
Colorado, Arizona, and Utah.	W91-10473 5G	LIU, P.
W91-11114 2F	LILLY, E.	Studies on the Situation of Pollution and Coun-
LEVKOV, L.	Ambient Air Co-Modeling in Alaska.	termeasures of Control of the Oceanic Environ-
Modelling the Atmospheric Transport of Trace	W91-11070 7C	ment in Zhoushan Fishing Ground: The Largest
Metals Including the Role of Precipitating	LIM, B.	Fishing Ground in China. W91-10559 5C
Clouds.	Sequential Sampling of Particles, Major Ions and	W91-10339
W91-11251 5B	Total Trace Metals in Wet Deposition.	LIU, S.
LEVY, D. A.	W91-11249 5B	Microbial Dechlorination of the Herbicide Me-
Shifts in Fish Vertical Distribution in Response	IIM T D	tolachlor.
to an Internal Seiche in a Stratified Lake.	LIM, T. P. 226-Ra and Other Radionuclides in Water,	W91-11377 5E
W91-10864 2H	Vegetation, and Tissues of Beavers (Castor cana-	LIVINGSTON, M. L.
LEWANDOWSKI, G.	densis) from a Watershed Containing U Tailings	Political Economic Model of International Pol-
Biodegradation of Benzene and a BTX Mixture	Near Elliot Lake, Canada.	lution.
Using Immobilized Activated Sludge.	W91-11454 5B	W91-11016 5E
W91-11381 5D	IIN M C	LIVINGSTONE, D. M.
LEWIS, J. C.	LIN, M. S. Role of Biotechnology in the Treatment of Geo-	Diel Oxygen Cycle in Three Subalpine Swiss
Geophysical and Chemical Investigations of	thermal Residual Sludges.	Streams.
Ground Water at Five Industrial or Waste-Dis-	W91-10744 5D	W91-10899 2H

LLEDO, M. J.	LOPEZ-AVILA, V.	LOVLEY, D. R.
Hydrological Balance of Two Mediterranean	Capillary Column Gas Chromatography With	Magnetite Formation During Microbial Dissimi-
Forested Catchments (Prades, Northeast Spain).	Nitrogen-Phosphorus Detection for Determina-	latory Iron Reduction.
W91-10963 2A	tion of Nitrogen-and Phosphorus-Containing	W91-11544 2J
LLOYD, B. J.	Pesticides in Finished Drinking Waters: Collabo- rative Study.	LOWER, M. W.
Effect of Heat Shock on Recovery of Escheri-	W91-11259 5A	Comprehensive Cooling Water Study, Final
chia coli from Drinking Water.		Report. Volume I: Summary of Environmental
W91-10628 5F	LOPEZ-CORTES, A.  Microbial Mats in Tidal Channels at San Carlos,	Effects.
Surveillance Solutions to Microbiological Prob-	Baja California Sur, Mexico.	W91-10729 5B
lems in Water Quality Control in Developing	W91-11400 2L	LOWRY, J. D.
Countries.	LOBEZ N	Measuring Low Radon Levels in Drinking
W91-10625 5G	LOPEZ, N. Overview of U.S. Geological Survey Water-	Water Supplies.
TOTM	Resources Information Programs.	W91-11463 5A
LO, J. M. Oil Spill Risk Simulation Model.	W91-11166 10D	
W91-11001 5B	LOPEZ PILA, J. M.	LUBRANO, L.
	Detection of Hepatitis A Virus and Other Enter-	Heavy Metal Speciation in Sewage Sludge Fol- lowing a Phyto-Dewatering Treatment.
LO, K. Y.	oviruses in Wastewater and Surface Water Sam-	W91-11147 5D
Electroosmotic Strengthening of Soft Sensitive	ples by Gene Probe Assay.	W)1-1114)
Clays. W91-10777 8D	W91-10665 5A	LUCOTTE, M.
W91-10///	Disinfection Capability in Water for Swimming	First-Order Organic Carbon Budget in the St
Field Test of Electroosmotic Strengthening of	and Bathing Pools: A Simple Method for Their	Lawrence Lower Estuary from 13C Data.
Soft Sensitive Clay.	Evaluation in Practice.	W91-10498 2L
W91-10778 8D	W91-10684 5F	LUDLOW, L.
LOAGUE, K.	LORAH, M. M.	What Stakeholders Want and Why.
Simple Design for Simultaneous Steady-State In-	Prospecting for Zones of Contaminated Ground-	W91-11035 6A
filtration Experiments with Ring Infiltrometers.	Water Discharge to Streams Using Bottom-Sedi-	
W91-10813 7B	ment Gas Bubbles.	LUDLOW, M. E.
TORR M. P.	W91-10951 5B	Occurrence of a South American Armored Cat-
LOBB, M. D. Habitat Use by an Assemblage of Fish in a Large	LORE, F.	fish in the Hillsborough River, Florida. W91-10855 2H
Warmwater Stream.	Influence of Polyelectrolyte Characteristics on	W91-10633
W91-11533 2H	Sludge Conditioning (Lab Evaluations).	LUGO, A. E.
	W91-10701 5D	Influence of Green Plants on the World Carbon
LODAYA, M.	LOSNO, R.	Budget.
Biodegradation of Benzene and a BTX Mixture	Major Ions in Marine Rainwater With Attention	W91-11071 2K
Using Immobilized Activated Sludge. W91-11381 5D	to Sources of Alkaline and Acidic Species.	LUSTIG, K. W.
W31-11361	W91-11250 5B	Innovative Subsurface Sewage Management: A
LODEWYK, S.	LOTITO, V.	Program to Protect Idaho's Rathdrum Prairie
Hydraulics of Culvert Fishways IV: Spoiler	Influence of Polyelectrolyte Characteristics on	Aquifer.
Baffle Culvert Fishways.	Sludge Conditioning (Lab Evaluations).	W91-11186 5G
W91-11279 8I	W91-10701 5D	LUTHER, G. W.
LOHVANSUU, J.	Technical Requirements and Possibilities of In-	Iodine Chemistry in the Water Column of the
Effects of Climate Change on Discharges and	cineration.	Chesapeake Bay: Evidence for Organic Iodine
Snow Cover in Finland.	W91-11129 5D	Forms.
W91-10964 2C	LOUCHOUARN, P.	W91-10496 2L
LOIZIDES, L.	First-Order Organic Carbon Budget in the St	Sales Barishand of Hamis Substance in a
Man-Made Garbage Pollution on the Mediterra-	Lawrence Lower Estuary from 13C Data.	Sulfur Enrichment of Humic Substances in a Delaware Salt Marsh Sediment Core.
nean Coastline.	W91-10498 2L	W91-11258 2L
W91-10569 5B	LOUREIRO, C. O.	***************************************
LOKESH, K. N.	Theoretical Study of the Significance of None-	LUTHER, M.
Studies on Assessment of Water Balance and Its	quilibrium Dissolution of Nonaqueous Phase	1-Naphthalenesulfonic acid and Sulfate as Sulfur
Quality in Gurpur River Basin, Karnataka State,	Liquids in Subsurface Systems. W91-11228 5B	Sources for the Green Alga Scenedesmus obli-
India.	W91-11228 5B	quus.
W91-11065 5B	LOUW, B.	W91-11326 5D
LOLL, U.	Evaluation of Fecal Enterococci Isolation Media	LUXMOORE, R. J.
CHP-Filter Press-The First Continuous High-	to Indicate Fecal Pollution in Chlorinated Water.	Hydrogeochemical Processes Controlling Sub-
Pressure Filter Press.	W91-10626 5F	surface Transport from an Upper Subcatchment
W91-10702 5D		of Walker Branch Watershed During Storm
West Berner Demotrale a with Balance Condi	LOVAS, R.	Events. 1. Hydrologic Transport Processes. W91-10907 5B
High-Pressure Dewatering with Polymer Condi- tioning as a Prerequisite for the Energy-Inde-	Bioaccumulation, Elimination and Metabolism of Triphenyltin Chloride by Early Life Stages of	W91-1090/
pendent Incineration of Sewage Sludge.	Minnows Phoxinus phoxinus.	Hydrogeochemical Processes Controlling Sub-
W91-11127 5D	W91-10877 5B	surface Transport from an Upper Subcatchment
	LOVELL, J. A.	of Walker Branch Watershed During Storm
LONGBOTTOM, J. E.	Drift of the Characin Larvae, Bryconamericus	Events. 2. Solute Transport Processes.
Capillary Column Gas Chromatography With Nitrogen-Phosphorus Detection for Determina-	deuterodonoides, During the Dry Season from	W91-10908 5B
tion of Nitrogen-and Phosphorus-Containing	Andean Piedmont Streams.	LYNCH, J. A.
Pesticides in Finished Drinking Waters: Collabo-	W91-11560 2H	Statistical Analysis of Errors in Estimating Wet
rative Study.	LOVETT-DOUST, L.	Deposition Using Five Surface Estimation Algo-
W91-11259 5A	Bioconcentration of Chlorinated Aromatic Hy-	rithms.
Direct Aqueous Injection-Liquid Chromatogra-	drocarbons in Aquatic Macrophytes.	W91-10474 7B
phy With Post-Column Derivatization for De-	W91-11338 5B	LYONS, J.
termination of N-Methylcarbamoyloximes and	Successes and Challenges in Developing and	Review of Fisheries Habitat Improvement
N-Methylcarbamates in Finished Drinking	Implementing Remedial Action Plans to Restore	Projects in Warmwater Streams, with Recom-
Water: Collaborative Study.	Degraded Areas of the Great Lakes.	mendations for Wisconsin.
W91-11260 5A	W91-11030 6A	W91-11591 2H

MACARI HERNANDEZ, J. A.	MALONE, T. C.	MARIOTTI, A.
Mathematical Modelling for Reservoir Water-	Environmental Research, Policy and Regula-	Nitrate Removal by Denitrification in Alluvial
Quality Management Through Hydraulic Struc- tures: A Case Study.	tion: The Chesapeake Bay Experience. W91-10575 5G	Ground Water: Role of a Former Channel.
W91-10490 5G	W91-10575 5G	W91-10909 5B
	MALTBY, L.	MARKERT M
MACDONALD, D. D.	Effect of Coal-Mine Effluent on Fungal Assem-	MARKERT, M.  Effect of 3,4-Dichloroaniline on the Early Life
Effects of Suspended Sediments on Aquatic	blages and Leaf Breakdown.	Stages of the Zebrafish (Brachydanio rerio): Re-
Ecosystems. W91-11426 5C	W91-11320 5C	sults of a Comparative Laboratory Study.
	MANABE, T.	W91-10828 5A
MACDONALD, E. K.	Bloom of Coscinodiscus wailesii and DO Deficit	W 31-10020
Liquid Effluents: New Solutions to Old Prob-	of Bottom Water in Seto Inland Sea.	MARRE, R.
lems. W91-11360 5D	W91-10549 5C	Pulsed Field Electrophoresis of Genomic Re-
		striction Fragments for the Detection of Noso-
MACHT, W.	MANDUJANO-VELAZQUEZ, J.	comial Legionella pneumophila in Hospital
Health Risk Assessment of Water Contaminants	Studies of Springs in the Southern Part of the Valley of Mexico (Estudio Crenologico en la	Water Supplies.
Using Baseline Data of Cancer Incidence in Dif-	Parte Meridional de la Cuenca de Mexico).	W91-10836 5A
ferent Water Supply Areas. W91-10614 5F	W91-11352 2E	MARGINATE IT C
	***************************************	MARSHALL, H. G.
MACKAY, D. M.	MANN, W. B.	Sediment Denitrification Potential in the Eliza-
Method for Assessing Residual NAPL Based on	U.S. Geological Survey Federal-State Coopera-	beth River, Virginia.
Organic Chemical Concentrations in Soil Sam-	tive Water-Resources Program Fiscal Year 1989.	W91-11537 5C
ples. W91-10797 5A	W91-11109 7B	MARSHALL, T. C.
W91-10797 5A	MANNIG, J.	Electrical and Kinematic Structure of the Strati-
MACKENZIE, S. H.	Preconcentration of Hydrophilic and Hydropho-	form Precipitation Region Trailing an Oklahoma
Challenge of Implementing Ecosystem Manage-	bic Pesticides from Aqueous Solutions and Ex-	Squall Line.
ment Plans in the Great Lakes Basin.	traction of Residues Using the Polymeric Sor-	W91-10514 2B
W91-11011 6B	bent Wofatit Y 77.	W91-10314 2B
MACKEY, H. E.	W91-11305 5A	MARTIN, A.
Comprehensive Cooling Water Study, Final		Geohydrology and Simulation of Flow in the
Report. Volume I: Summary of Environmental	MANNILA, J. P.	Chicot Aquifer System of Southwestern Louisi-
Effects.	High-Performance Liquid Chromatographic	ana.
W91-10729 5B	Study on Oxidation Products of Lignin and Humic Substances.	W91-11100 2F
MACKIE, K. L.	W91-11513 5A	
Effects of Chlorination Conditions On the AOX	W91-11515	MARTIN, J. D.
and Chlorinated Phenol Content of Kraft Bleach	MANOS, A.	Description of the Physical Environment and
Plant Wastewaters.	International Programme for the Protection of a	Coal-Mining History of West-Central Indiana,
W91-11474 5D	Semi-Enclosed Sea: The Mediterranean Action	with Emphasis on Six Small Watersheds.
Toursellies of Disselect Keep Bule and Banes	Plan.	W91-11576 2E
Treatability of Bleached Kraft Pulp and Paper Mill Wastewaters In a New Zealand Aerated	W91-10574 5G	244 (1999)
Lagoon Treatment System.	MANSINGH, A.	MARTIN, N.
		Efficiency of an Ozoflotation-Filtration Process
W91-11499 5D	Dynamics of Pesticides in Tropical Conditions.	for the Treatment of the River Thames at
W91-11499 5D MACLEAN, A. G.	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis,	for the Treatment of the River Thames at Walton Works.
W91-11499 5D  MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of	Dynamics of Pesticides in Tropical Conditions.	for the Treatment of the River Thames at
W91-11499 5D  MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration.	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta	for the Treatment of the River Thames at Walton Works. W91-11268 5F
W91-11499 5D  MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984 8B	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  5B	for the Treatment of the River Thames at Walton Works. W91-11268 5F MARTIN, T. J.
W91-11499 5D  MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984 8B  MAEDA, M.	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  5B  MARANI, A.	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in
W91-11499 5D  MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984 8B  MAEDA, M. Kansai International Airport Project and Envi-	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  MARANI, A.  Geomorphological Dispersion.	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.
W91-11499 5D  MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984 8B  MAEDA, M. Kansai International Airport Project and Envi- ronmental Impact Assessment.	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  5B  MARANI, A.	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in
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W91-11499 5D  MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984 8B  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563 4C  MAETZOLD, J. A.	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  MARANI, A.  Geomorphological Dispersion.  W91-11232  ZE  MARECHAL, J.  Detection of Hepatitis A Virus and Other Enter-	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  MARTINI, A.  Heavy Metal Transport to the Great Lakes by
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Envi- ronmental Impact Assessment. W91-10563  AC  MAETZOLD, J. A. National Program for Soil and Water Conserva-	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  MARANI, A. Geomorphological Dispersion.  W91-11232  ZE  MARECHAL, J.	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  MARTINI, A.
W91-11499 5D  MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984 8B  MAEDA, M. Kansai International Airport Project and Envi- ronmental Impact Assessment. W91-10563 4C  MAETZOLD, J. A. National Program for Soil and Water Conserva- tion. Its Effect on USDA Services.	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  MARANI, A. Geomorphological Dispersion.  W91-11232  2E  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay.	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  MARTINI, A.  Heavy Metal Transport to the Great Lakes by
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W91-11499 5D  MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984 8B  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563 4C  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169 3F	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  MARANI, A. Geomorphological Dispersion.  W91-11232  2E  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay.  W91-10665  5A	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  2E  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  5B
W91-11499 5D  MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984 8B  MAEDA, M. Kansai International Airport Project and Envi- ronmental Impact Assessment. W91-10563 4C  MAETZOLD, J. A. National Program for Soil and Water Conserva- tion. Its Effect on USDA Services.	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  MARANI, A. Geomorphological Dispersion.  W91-11232  ZE  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay.  W91-10665  MARER, P. J.	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  MARTINO, P.
W91-11499 5D  MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984 8B  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563 4C  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169 3F  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures.	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  MARANI, A. Geomorphological Dispersion.  W91-11232  ZE  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay.  W91-10665  5A  MARER, P. J. Developing a Groundwater Training Program	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  MARTINO, P.  Simplified Phosphorus Trophic State Model for
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  4C  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  3F  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conserva-	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  MARANI, A. Geomorphological Dispersion.  W91-11232  2E  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay.  W91-10665  5A  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users.	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  2E  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  MARTINO, P.  Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  4C  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  3F  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11567  4D	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  MARANI, A. Geomorphological Dispersion.  W91-11232  ZE  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay.  W91-10665  5A  MARER, P. J. Developing a Groundwater Training Program	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  MARTINO, P.  Simplified Phosphorus Trophic State Model for
W91-11499 5D  MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984 8B  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563 4C  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169 3F  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11567 4D  Economic Analysis of Soil Conservation Tech-	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  MARANI, A. Geomorphological Dispersion.  W91-11232  ZE  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay.  W91-10665  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users.  W91-11199  5G  MARGOLIN, A. B.	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  2E  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  MARTINO, P.  Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.  W91-11332  5C
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  4C  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  3F  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11567  4D  Economic Analysis of Soil Conservation Technologies.	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan. W91-11375  MARANI, A. Geomorphological Dispersion. W91-11232  2E  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay. W91-10665  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users. W91-11199  5G  MARGOLIN, A. B. Application of a Poliovirus cDNA Probe for the	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  2E  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  5B  MARTINO, P.  Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.  W91-11332  MARTINS, M. T.
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MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  AC  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  3F  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11567  4D  Economic Analysis of Soil Conservation Technologies. W91-11566  4D	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375 5B  MARANI, A. Geomorphological Dispersion.  W91-11232 2E  MARECHAL, J. Detection of Hepatitis A Virus and Other Enter-oviruses in Wastewater and Surface Water Samples by Gene Probe Assay.  W91-10665 5A  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users.  W91-11199 5G  MARGOLIN, A. B. Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water.  W91-10667 5A	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  MARTINO, P.  Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.  W91-11332  MARTINS, M. T.  Occurrence of V. cholerae 0:1 Non-Toxigenic in
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  AC  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11567  4D  Economic Analysis of Soil Conservation Technologies. W91-11566  4D  Strategic Issues in Watershed Development. W91-11564  MAJOR, J. J.	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan. W91-11375  MARANI, A. Geomorphological Dispersion. W91-11232  2E  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay. W91-10665  5A  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users. W91-11199  5G  MARGOLIN, A. B. Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water. W91-10667  5A  MARIN-CORDOBA, S.	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  MARTINO, P.  Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.  W91-11332  MARTINS, M. T.  Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  AC  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  3F  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11567  Economic Analysis of Soil Conservation Technologies. W91-11566  Strategic Issues in Watershed Development. W91-11566  MAJOR, J. J. Snow and Ice Perturbation during Historical	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375 5B  MARANI, A. Geomorphological Dispersion.  W91-11232 2E  MARECHAL, J. Detection of Hepatitis A Virus and Other Enter-oviruses in Wastewater and Surface Water Samples by Gene Probe Assay.  W91-10665 5A  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users.  W91-11199 5G  MARGOLIN, A. B. Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water.  W91-10667 5A	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  2E  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  MARTINO, P.  Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.  W91-11332  5C  MARTINS, M. T.  Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.  W91-10685  MARVELDE, J. H. B.
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  4C  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  3F  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11567  4D  Economic Analysis of Soil Conservation Technologies. W91-11566  4D  Strategic Issues in Watershed Development. W91-11564  MAJOR, J. J. Snow and Ice Perturbation during Historical Volcanic Eruptions and the Formation of	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan. W91-11375  MARANI, A. Geomorphological Dispersion. W91-11232  ZE  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay. W91-10665  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users. W91-11199  SG  MARGOLIN, A. B. Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water. W91-10667  MARIN-CORDOBA, S. Studies of Springs in the Southern Part of the Valley of Mexico (Estudio Crenologico en la Parte Meridional de la Cuenca de Mexico).	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  MARTINO, P.  Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.  W91-11332  MARTINS, M. T.  Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  AC  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11567  4D  Economic Analysis of Soil Conservation Technologies. W91-11566  AD  Strategic Issues in Watershed Development. W91-11564  MAJOR, J. J. Snow and Ice Perturbation during Historical Volcanic Eruptions and the Formation of Lahars and Floods.	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375 5B  MARANI, A. Geomorphological Dispersion.  W91-11232 2E  MARECHAL, J. Detection of Hepatitis A Virus and Other Enter-oviruses in Wastewater and Surface Water Samples by Gene Probe Assay.  W91-10665 5A  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users.  W91-11199 5G  MARGOLIN, A. B. Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water.  W91-10667 5A  MARIN-CORDOBA, S. Studies of Springs in the Southern Part of the Valley of Mexico (Estudio Crenologico en la	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  2E  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  5B  MARTINO, P.  Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.  W91-11332  MARTINS, M. T.  Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.  W91-10685  MARVELDE, J. H. B.  Sludge Treatment and Tipping Site Hartel-
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  4C  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  3F  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11567  4D  Economic Analysis of Soil Conservation Technologies. W91-11566  4D  Strategic Issues in Watershed Development. W91-11564  MAJOR, J. J. Snow and Ice Perturbation during Historical Volcanic Eruptions and the Formation of	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  MARANI, A. Geomorphological Dispersion.  W91-11232  ZE  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay.  W91-10665  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users.  W91-11199  SG  MARGOLIN, A. B. Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water.  W91-10667  MARIN-CORDOBA, S. Studies of Springs in the Southern Part of the Valley of Mexico (Estudio Crenologico en la Parte Meridional de la Cuenca de Mexico).  W91-11352	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J. Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  2E  MARTINI, A. Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  5B  MARTINO, P. Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.  W91-11332  5C  MARTINS, M. T. Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.  W91-10685  MARVELDE, J. H. B. Sludge Treatment and Tipping Site 'Hartelmond'.
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11567  Economic Analysis of Soil Conservation Technologies. W91-11566  Strategic Issues in Watershed Development. W91-11564  MAJOR, J. J. Snow and Ice Perturbation during Historical Volcanic Eruptions and the Formation of Lahars and Floods. W91-11394  MALLEY, J. P.	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan. W91-11375  MARANI, A. Geomorphological Dispersion. W91-11232  ZE  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay. W91-10665  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users. W91-11199  SG  MARGOLIN, A. B. Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water. W91-10667  MARIN-CORDOBA, S. Studies of Springs in the Southern Part of the Valley of Mexico (Estudio Crenologico en la Parte Meridional de la Cuenca de Mexico). W91-11352  MARIN, M. G.	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  2E  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  5B  MARTINO, P.  Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.  W91-11332  5C  MARTINS, M. T.  Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.  W91-10685  MARVELDE, J. H. B.  Sludge Treatment and Tipping Site 'Hartelmond'.  W91-11140  MASON, C. A.
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  4C  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  3F  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11567  4D  Economic Analysis of Soil Conservation Technologies. W91-11566  4D  Strategic Issues in Watershed Development. W91-11564  MAJOR, J. J. Snow and Ice Perturbation during Historical Volcanic Eruptions and the Formation of Lahars and Floods. W91-11394  MALLEY, J. P. Removal of Humic Substances and Algae by	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  MARANI, A. Geomorphological Dispersion.  W91-11232  2E  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay.  W91-10665  5A  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users.  W91-11199  5G  MARGOLIN, A. B. Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water.  W91-10667  5A  MARIN-CORDOBA, S. Studies of Springs in the Southern Part of the Valley of Mexico (Estudio Crenologico en la Parte Meridional de la Cuenca de Mexico).  W91-11352  ZE  MARIN, M. G. Effects of Linear Alkylbenzene Sulphonate	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  2E  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  MARTINO, P.  Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.  W91-11332  MARTINS, M. T.  Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.  W91-10685  MARVELDE, J. H. B.  Sludge Treatment and Tipping Site 'Hartelmond'.  W91-11140  MASON, C. A.  UV Disinfection: Short Term Inactivation and
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11567  Leonomic Analysis of Soil Conservation Technologies. W91-11566  Strategic Issues in Watershed Development. W91-11564  MAJOR, J. J. Snow and Ice Perturbation during Historical Volcanic Eruptions and the Formation of Lahars and Floods. W91-11394  MALLEY, J. P. Removal of Humic Substances and Algae by Dissolved Air Flotation.	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan. W91-11375  MARANI, A. Geomorphological Dispersion. W91-11232  2E  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay. W91-10665  5A  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users. W91-11199  5G  MARGOLIN, A. B. Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water. W91-10667  SA  MARIN-CORDOBA, S. Studies of Springs in the Southern Part of the Valley of Mexico (Estudio Crenologico en la Parte Meridional de la Cuenca de Mexico). W91-11352  MARIN, M. G. Effects of Linear Alkylbenzene Sulphonate (LAS) on Skeletal Development of Sea Urchin	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J. Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  2E  MARTINI, A. Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  5B  MARTINO, P. Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.  W91-11332  MARTINS, M. T. Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.  W91-10685  MARVELDE, J. H. B. Sludge Treatment and Tipping Site 'Hartelmond'.  W91-11140  MASON, C. A.  UV Disinfection: Short Term Inactivation and Revival.
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  4C  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  3F  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11567  4D  Economic Analysis of Soil Conservation Technologies. W91-11566  4D  Strategic Issues in Watershed Development. W91-11564  MAJOR, J. J. Snow and Ice Perturbation during Historical Volcanic Eruptions and the Formation of Lahars and Floods. W91-11394  MALLEY, J. P. Removal of Humic Substances and Algae by	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan. W91-11375  MARANI, A. Geomorphological Dispersion. W91-11232  EMARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay. W91-10665  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users. W91-11199  MARGOLIN, A. B. Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water. W91-10667  MARIN-CORDOBA, S. Studies of Springs in the Southern Part of the Valley of Mexico (Estudio Crenologico en la Parte Meridional de la Cuenca de Mexico). W91-11322  MARIN, M. G. Effects of Linear Alkylbenzene Sulphonate (LAS) on Skeletal Development of Sea Urchin Embryos (Paracentrotus lividus LMK).	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  2E  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  MARTINO, P.  Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.  W91-11332  MARTINS, M. T.  Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.  W91-10685  MARVELDE, J. H. B.  Sludge Treatment and Tipping Site 'Hartelmond'.  W91-11140  MASON, C. A.  UV Disinfection: Short Term Inactivation and Revival.
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  AC  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11567  Leonomic Analysis of Soil Conservation Technologies. W91-11566  Strategic Issues in Watershed Development. W91-11564  MAJOR, J. J. Snow and Ice Perturbation during Historical Volcanic Eruptions and the Formation of Lahars and Floods. W91-11394  MALLEY, J. P. Removal of Humic Substances and Algae by Dissolved Air Flotation. W91-10751	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan. W91-11375  MARANI, A. Geomorphological Dispersion. W91-11232  2E  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay. W91-10665  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users. W91-11199  5G  MARGOLIN, A. B. Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water. W91-10667  MARIN-CORDOBA, S. Studies of Springs in the Southern Part of the Valley of Mexico (Estudio Crenologico en la Parte Meridional de la Cuenca de Mexico). W91-11352  MARIN, M. G. Effects of Linear Alkylbenzene Sulphonate (LAS) on Skeletal Development of Sea Urchin Embryos (Paracentrotus lividus LMK). W91-10891	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  2E  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  MARTINO, P.  Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.  W91-11332  MARTINS, M. T.  Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.  W91-10685  MARVELDE, J. H. B.  Sludge Treatment and Tipping Site 'Hartelmond'.  W91-11140  MASON, C. A.  UV Disinfection: Short Term Inactivation and Revival.  W91-10680
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11566  Economic Analysis of Soil Conservation Technologies. W91-11566  MAJOR, J. J. Snow and Ice Perturbation during Historical Volcanic Eruptions and the Formation of Lahars and Floods. W91-11394  MALLEY, J. P. Removal of Humic Substances and Algae by Dissolved Air Flotation. W91-10751  MALLORY, M. J. Evaluation of Three Scenarios of Ground-Water	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  MARANI, A. Geomorphological Dispersion. W91-11232  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay. W91-10665  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users. W91-11199  MARGOLIN, A. B. Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water. W91-10667  MARIN-CORDOBA, S. Studies of Springs in the Southern Part of the Valley of Mexico (Estudio Crenologico en la Parte Meridional de la Cuenca de Mexico). W91-11352  MARIN, M. G. Effects of Linear Alkylbenzene Sulphonate (LAS) on Skeletal Development of Sea Urchin Embryos (Paracentrotus lividus LMK). W91-10891  SC  MARINO, M. G.	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  MARTINO, P.  Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.  W91-11332  MARTINS, M. T.  Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.  W91-10685  MARVELDE, J. H. B.  Sludge Treatment and Tipping Site 'Hartelmond'.  W91-11140  MASON, C. A.  UV Disinfection: Short Term Inactivation and Revival.  W91-10680  MASSE, A.
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11567  Economic Analysis of Soil Conservation Technologies. W91-11566  Strategic Issues in Watershed Development. W91-11564  MAJOR, J. J. Snow and Ice Perturbation during Historical Volcanic Eruptions and the Formation of Lahars and Floods. W91-11394  MALLEY, J. P. Removal of Humic Substances and Algae by Dissolved Air Flotation. W91-10751  MALLORY, M. J. Evaluation of Three Scenarios of Ground-Water Withdrawal from the Mississippi River Alluvial	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan.  W91-11375  MARANI, A. Geomorphological Dispersion.  W91-11232  ZE  MARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay.  W91-10665  SA  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users.  W91-11199  SG  MARGOLIN, A. B. Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water.  W91-10667  MARIN-CORDOBA, S. Studies of Springs in the Southern Part of the Valley of Mexico (Estudio Crenologico en la Parte Meridional de la Cuenca de Mexico).  W91-11352  MARIN, M. G. Effects of Linear Alkylbenzene Sulphonate (LAS) on Skeletal Development of Sea Urchin Embryos (Paracentrotus lividus LMK).  W91-10891  SC  MARINO, M. G. Man-Made Garbage Pollution on the Mediterra-	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  MARTINO, P.  Simplified Phosphorus Trophic State Model for Warn-Water Tropical Lakes.  W91-11332  MARTINS, M. T.  Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.  W91-10685  MARVELDE, J. H. B.  Sludge Treatment and Tipping Site 'Hartelmond'.  W91-11140  MASON, C. A.  UV Disnification: Short Term Inactivation and Revival.  W91-10680  MASSE, A.  Summer Circulation in the Kingston Basin, Lake
MACLEAN, A. G. Open Channel Velocity Profiles over a Zone of Rapid Infiltration. W91-10984  MAEDA, M. Kansai International Airport Project and Environmental Impact Assessment. W91-10563  MAETZOLD, J. A. National Program for Soil and Water Conservation. Its Effect on USDA Services. W91-11169  MAGRATH, W. B. Economic Analysis of Off-Farm Soil Conservation Structures. W91-11566  Economic Analysis of Soil Conservation Technologies. W91-11566  MAJOR, J. J. Snow and Ice Perturbation during Historical Volcanic Eruptions and the Formation of Lahars and Floods. W91-11394  MALLEY, J. P. Removal of Humic Substances and Algae by Dissolved Air Flotation. W91-10751  MALLORY, M. J. Evaluation of Three Scenarios of Ground-Water	Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta Endosulfan. W91-11375  MARANI, A. Geomorphological Dispersion. W91-11232  EMARECHAL, J. Detection of Hepatitis A Virus and Other Enteroviruses in Wastewater and Surface Water Samples by Gene Probe Assay. W91-10665  MARER, P. J. Developing a Groundwater Training Program for Pesticide Users. W91-11199  MARGOLIN, A. B. Application of a Poliovirus cDNA Probe for the Detection of Enteroviruses in Water. W91-10667  MARIN-CORDOBA, S. Studies of Springs in the Southern Part of the Valley of Mexico (Estudio Crenologico en la Parte Meridional de la Cuenca de Mexico). W91-11352  MARIN, M. G. Effects of Linear Alkylbenzene Sulphonate (LAS) on Skeletal Development of Sea Urchin Embryos (Paracentrotus lividus LMK). W91-10891  SC  MARINO, M. G. Ann-Made Garbage Pollution on the Mediterranean Coastline.	for the Treatment of the River Thames at Walton Works.  W91-11268  MARTIN, T. J.  Comparison of Nocturnal Drainage Flow in Three Tributaries.  W91-10501  2E  MARTINI, A.  Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial Evaluation.  W91-11062  5B  MARTINO, P.  Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.  W91-11332  5C  MARTINS, M. T.  Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.  W91-10685  MARVELDE, J. H. B.  Sludge Treatment and Tipping Site 'Hartelmond'.  W91-11140  5D  MASON, C. A.  UV Disinfection: Short Term Inactivation and Revival.  W91-10680  5H  MASSE, A.  Summer Circulation in the Kingston Basin, Lake Ontario.

MASUNAGA, S.	MCCARTY, P. L.	MCLELLON, W. M.
Behavior of Chlorobenzenes in Ise Bay, Estimat- ed from Their Concentrations in Various Envi-	Comparison Between Model Simulations and	Student Water Use.
ronmental Media.	Field Results for In-Situ Biorestoration of Chlor- inated Aliphatics: Part 1. Biostimulation of	W91-11460 6D
W91-11325 5B	Methanotrophic Bacteria.	MCMURDIE, L. A.
Distribution of Chlorabassass in the Batters	W91-10955 5G	Satellite-Derived Integrated Water-Vapor Dis-
Distribution of Chlorobenzenes in the Bottom Sediments of Ise Bay.	Electrolytic Model System for Reductive Deha-	tribution in Oceanic Midlatitude Storms: Varia-
W91-11324 5B	logenation in Aqueous Environments.	tion with Region and Season.
	W91-11343 5B	W91-11419 2B
MATHUR, K. C. K. Comparative Physico-Chemical Analysis of	MCCOMB, A. J.	MCNABB, G. D.
Drinking, Ground and Industrial Waste Water	Macroalgal-Sediment Nutrient Interactions and	Brine-Induced Advection of Dissolved Aromat-
of Jodhpur.	Their Importance to Macroalgal Nutrition in a	ic Hydrocarbons to Arctic Bottom Waters.
W91-11083 5B	Eutrophic Estuary.	W91-11340 5B
Estimation of Trace Metals Levels in Power and	W91-10497 2L	MCNEIL, E. J.
Industrial Waste Water of Jodhpur by Differen-	MCCUTCHEON, S. C.	Bioconcentration of Chlorinated Aromatic Hy-
tial Pulse Anodic Stripping Voltammetry. W91-11084 5A	Fate and Transport of Sediment-Associated	drocarbons in Aquatic Macrophytes.
	Contaminants. W91-11587 5B	W91-11338 5B
MATHUR, M. Comparative Physico-Chemical Analysis of		MEARNS, L. O.
Drinking, Ground and Industrial Waste Water	MCDONALD, A.	Approaches to the Simulation of Regional Cli-
of Jodhpur.	Seasonal Changes in the Sanitary Bacterial Qual- ity of Water Draining a Small Upland Catch-	mate Change: A Review.
W91-11083 5B	ment in the Yorkshire Dales.	W91-11427 5C
MATISOFF, G.	W91-10935 5B	ASSESSED F
Computer Modeling of Scale Formation During	MCDOUGALL, S.	MECHSNER, K. UV Disinfection: Short Term Inactivation and
Treatment of Ground Water in Air Strippers.	Dynamic Model of Caesium Transport in Lakes	Revival.
W91-10798 3G	and Their Catchments.	W91-10680 5F
MATTHEWS, P. J.	W91-10934 5B	
Modern Sludge Management: The Manager's Choice.	MCFARLANE, P. N.	MEDEMA, G. J.
W91-11122 5D	Development of Environmental Control Legis-	Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems.
	lation and Effluent Standards for Australasian	W91-10677 5F
MATTHEY, W. Use of Sewage Sludge on Agricultural Land:	Wood Processing Industries. W91-11472 5G	***************************************
Impact on Soil Fauna.	W91-114/2 3G	MEDINE, A. J.
W91-11150 5E	Effects of Chlorination Conditions On the AOX	Fate and Transport of Sediment-Associated
MATTUSCH, J.	and Chlorinated Phenol Content of Kraft Bleach Plant Wastewaters.	Contaminants. W91-11587 5B
Flow-Rate Variated HPLC-/EC-Determination	W91-11474 5D	W91-11367
of Phenols.		MEEDER, C. N.
W91-11257 5A	Treatability of Bleached Kraft Pulp and Paper Mill Wastewaters In a New Zealand Aerated	Fluctuating Water Levels in the Great Lakes-St.
MAUGHAN, D. W.	Lagoon Treatment System.	Lawrence River Basin: An Evaluation Frame-
Modification of Benthic Community Structure	W91-11499 5D	work for the Analysis of Potential Actions. W91-11026 6B
in Response to Acid-Iron Wastes Discharge. W91-10869 5C	MCCANN P. T.	W 91-11020
	MCGANN, B. T. Efficiency With Which Drizzle and Precipita-	MEIER, M. F.
MAURER, D. Coefficient of Pollution (p): The Southern Cali-	tion Sized Drops Collide With Aerosol Particles.	Variability of Glacier Mass Balances in Western
fornia Shelf and Some Ocean Outfalls.	W91-11252 2B	North America.
W91-10874 5B	MCGINLEY, P. M.	W91-11391 2C
MAYER, G. C.	Sorption Phenomena in Subsurface Systems:	MEINESZ, A.
Ground-Water Flow and Stream-Aquifer Rela-	Concepts, Models, and Effects on Contaminant	Impact of Coastal Development on the Infralit-
tions in the Northern Coastal Plain of Georgia	Fate and Transport.	toral Zone Along the Southeastern Mediterrane
and Adjacent Parts of Alabama and South Caro-	W91-10882 5B	an Shore of Continental France. W91-10562 6G
lina. W91-11598 2F	MCILVRIDE, W.	W91-10302
	Soil Vapor Survey at the LLNL Site 300 Gener-	MEISCHNER, P. F.
MAYS, P. A. Ozone, Acidic Precipitation, and Soil Mg Ef-	al Services Area, Adjacent Portions of the Con- nolly and Gallo Ranches and the Site 300 Land-	Squall Line in Southern Germany: Kinematics
fects on Growth and Nutrition of Loblolly Pine	fill Pit 6 Area.	and Precipitation Formation as Deduced by Ad
Seedlings.	W91-10747 5B	vanced Polarimetric and Doppler Radar Meas urements.
W91-10918 5C	MCKAY, N.	W91-11420 2E
MAZZELLA, A. J.	Environmental Management of the Puget	
Case Studies in Data Analysis.	Sound.	MEISSNER, S. M.
W91-10733 2B	W91-10577 5G	Coliphage and Bacteriophage as Indicators of
MCCABE, G. J.	MCKEEN, P. L.	Recreational Water Quality. W91-11334 5A
Simulated Hydrologic Effects of Climatic	Provincial Guidelines to Great Lakes Shoreline	W 21-11334
Change in the Delaware River Basin. W91-11060 5C	Management Plans.	MELCHER, J.
	W91-11024 6E	Primary Productivity and Plankton Communi
Simulation of Precipitation by Weather Type	MCLAURIN, I. S.	ties in a Two-Reservoir Series.
Analysis. W91-11230 2B	Hydrometric Data Collection and Interpretation	W91-10815 2F
	in the Prairie Provinces and Northwest Territo-	MELCHER, N. B.
MCCALL, D. E.	ries. W91-11278 7A	Statistical Summaries of Selected Iowa Stream
Comparative Inactivation of Hepatitis A Virus and Other Enteroviruses in Water by Iodine.		flow Data Through September 30, 1988.
W91-10679 5F	MCLEAN, C.	W91-10770 21
MCCAMMON, N. R.	Effect of Three Primary Treatment Sewage Outfalls on Metal Concentrations in the Fish	MELIN, E.
Deep-Seated Consolidation Settlements in the	Cheilodactylus fuscus Collected Along the	Oxic Fluidized-Bed Treatment of Dichloropher
Fraser River Delta.	Coast of Sydney, Australia.	ols.
W91-10948 8D	W91-10873 5B	W91-11485 5I

5D

MELONI, E. Practical Experience with Biological Removal	mium) in Different Organ Systems of the Fresh- water Crayfish, Astacus astacus L. (Crustacea:	MISHRA, B. K. Leaching of Ammonium Nitrate under Field
of Phosphorus from Pulp and Paper Mill Ef- fluents.	Decapoda). W91-10827 5B	Conditions: Studies on Kinetics of Nitrification and Nitrate Reduction in an Ultisol Profile.
W91-11496 5D	MIHNEA, P. E.	W91-10999 5B
MELVIN, M. A. L.	Present State of Environmental Pollution in	MICHIENICS A C
Sheep-Dips as a Source of Pollution of Fresh-	Coastal Sea Area and Measures for Protection.	MISKIEWICZ, A. G. Effect of Three Primary Treatment Sewage
waters: A Study in Grampian Region.	W91-10540 5B	Outfalls on Metal Concentrations in the Fish
W91-11356 5B	MIICHI, A.	Cheilodactylus fuscus Collected Along the
MENENDEZ, A. N.	Personal Computer System Supporting Water	Coast of Sydney, Australia.
Mathematical Simulation of Pollutant Disper-	Quality Management in Eutrophicated Bay.	W91-10873 5B
sion. W91-10488 5B	W91-10582 5G	MISRA, C.
	MIKHEEV, I. I.	Leaching of Ammonium Nitrate under Field
MENGES, C. M.	Intake Devices for Dredges with Submersible	Conditions: Studies on Kinetics of Nitrification
Application of Uphole Data from Petroleum Seismic Surveys to Groundwater Investigations,	Suction Pumps. W91-11287 8C	and Nitrate Reduction in an Ultisol Profile. W91-10999 5B
Abu Dhabi (United Arab Emirates).		
W91-11399 7C	MIKULA, R. Lake Lansing Dredging Evaluation Study, 1978-	MITCH, M. E.
MENGES, E. S.	1984.	Stream Chemistry in the Eastern United States:  1. Synoptic Survey Design, Acid-Base Status,
Effects of Land Use Alteration on Tropical	W91-10748 5G	and Regional Patterns.
Carbon Exchange.	MILLER, D. C.	W91-11241 5B
W91-11072 4C	Hazard Assessment Research Strategy for	0 0 1 1 1 1 7 7 7 7 1 7 1 7 1 7 1 7 1 7
MERILLOT, J. M.	Ocean Disposal.	Stream Chemistry in the Eastern United States: 2. Current Sources of Acidity in Acidic and
Examples of Agricultural Use of Residual	W91-11551 5E	Low Acid-Neutralizing Capacity Streams.
Sludge.	MILLER, R. A.	W91-11242 5B
W91-11139 5D	Establishment of a Groundwater Research Data	
MERKEL, I. W.	Center for Validation of Subsurface Flow and	MITTON, G. B.
Situation of Water Supply in the New Lander of	Transport Models.	Monthly Mean Discharge at and Between Se- lected Streamflow-Gaging Stations Along the
the Federal Republic of Germany. W91-11272 5F	W91-10736 2F	Mississippi, Minnesota, and St. Croix Rivers,
W91-11272 5F	MILLER, R. J.	1932-87.
MESSER, J. J.	Use of the Intertidal Zone by Fish in Nova	W91-10760 2E
Stream Chemistry in the Eastern United States:	Scotia. W91-11557 2L	MIYAZAKI, T.
<ol> <li>Synoptic Survey Design, Acid-Base Status, and Regional Patterns.</li> </ol>	W91-11557 2L	Field Survey and Hydraulic Study of 'Aoshio' in
W91-11241 5B	MILLY, P. C. D.	Tokyo Bay.
	Refinement of the Combination Equations for	W91-10529 5C
MESSING, I. Modelling Water and Solute Transport in Ma-	Evaporation. W91-11398 2K	MLAKAR, P. F.
croporous Soil. I. Model Description and Sensi-		Predicting Concrete Service Life in Cases of
tivity Analysis.	MILNE, D. P. Effect of Dissolved Nutrients and Inorganic Sus-	Deterioration Due to Freezing and Thawing.
W91-10803 5B	pended Solids on the Survival of E. coli in	W91-10734 8F
METCALFE, C, D,	Seawater.	MOBIUS, C. H.
Enhancement of Hepatocarcinogenesis in Rain-	W91-10638 5B	Nitrogen and Phosphorus Limits for Nutrient
bow Trout with Carbon Tetrachloride. W91-11301 5C	MILSTEIN, O.	Deficient Industrial Wastewaters.
W91-11301 5C	Decrease of Pollutant Level of Bleaching Ef-	W91-11494 5D
METHVEN, B.	fluents and Winning Valuable Products by Suc-	MOCK, N.
Effect of a Chelating Agent (DTPA) on Anaero-	cessive Flocculation and Microbial Growth. W91-11488 5D	Self-Affine Scaling and Subsurface Response to
bic Wastewater Treatment in an Upflow Sludge Blanket Filter.	W91-11400	Snowmelt in Steep Terrain.
W91-11277 5D	MINERS, K.	W91-10912 2G
NAMES II	Summer Circulation in the Kingston Basin, Lake	MODELL, R.
METZ, H. Coliform Bacteria in Drinking Water from	Ontario. W91-10978 2H	Conductivity for Nutrient Control In CTMP
South Bavaria: Identification by the API 20E-		Wastewater Treatment.
System and Resistance Patterns.	MINET, J. Salmonella Detection in Sewage Waters Using	W91-11495 5D
W91-10627 5F	Fluorescent Antibodies.	MOELLER, J.
MEULEMANS, C. C. E.	W91-10687 5D	Determination of Trace Levels of Sulphate in
F-Specific RNA Bacteriophages as Model Vi-	MININNI, G.	Water Using Flow-Injection and In-Line Pre-
ruses in UV Disinfection of Wastewater.	Physical and Chemical Characterization of	concentration.
W91-10682 5D	Sewage Sludge.	W91-11246 2K
MEXIA, J. T.	W91-11117 5D	MOLNAR, A.
Contribution for the Study of New Pathogenic	MINSHALL, G. W.	Land Tenure Issues in Watershed Development.
Indicators Removal from W. S. P. in Portugal. W91-10689 5D	Longitudinal Development of Macroinverte-	W91-11569 6F
	brate Communities Below Oligotrophic Lake	MOLOFSKY, J.
MEYER, A.	Outlets. W91-10856 2H	Effects of Land Use Alteration on Tropical
Comparison of Amperometric and UV-Spectro- photometric Monitoring in the HPLC Analysis		Carbon Exchange.
of Pesticides.	MIRKA, M. A.	W91-11072 4C
W91-11306 5A	226-Ra and Other Radionuclides in Water, Vegetation, and Tissues of Beavers (Castor cana-	MONK, R. B.
MEYER, R. P.	densis) from a Watershed Containing U Tailings	Channel Tunnel and Its Impact on the Folkes-
Effect of Pesticide Treatments on Nontarget Or-	Near Elliot Lake, Canada.	tone and District Water Company.
ganisms in California Rice Paddies.	W91-11454 5B	W91-11363 4C
W91-10835 5C	MISHIMA, Y.	MONOSOWSKI, E.
MEYER, W.	Scavenging Processes of Marine Particles in	Dams and Sustainable Development in Brazilian
Biochemical and Histochemical Observations on	Osaka Bay.	Amazonia.
Effects of Low-Level Metal Load (Lead, Cad-	W91-10538 5B	W91-11216 8C

MONROE, M. W. Environmental Activism in the San Francisco	MORIN, R. H. Analysis and Interpretation of the Borehole	International Boundary and Water Commission, United States and Mexico.
Bay Estuary. W91-10585 5G	Televiewer Log: Information on the State of	W91-11388 6E
W91-10363	Stress and the Lithostratigraphy at Hole 504B. W91-11549	MUR, L. R.
MONSON, S. J.	W91-11349 /C	Microcystis Changes its Buoyancy in Response
Major Incident of Dioxin Contamination: Sedi-	Graphical Method for Determining the Coeffi-	to the Average Irradiance in the Surface Mixed
ments of New Jersey Estuaries.	cient of Consolidation cv from a Flow-Pump	Layer.
W91-11341 5B	Permeability Test. W91-11393 7C	W91-10895 2H
MONTANI, S.	W91-11393 /C	MIDAONA P
Scavenging Processes of Marine Particles in	MORIOKA, T.	MURAOKA, K. Field Survey and Hydraulic Study of 'Aoshio' in
Osaka Bay.	Personal Computer System Supporting Water	Tokyo Bay.
W91-10538 5B	Quality Management in Eutrophicated Bay. W91-10582 5G	W91-10529 5C
MOODY, D. W.	W 21-10362	
Sources and Extent of Groundwater Contamina-	MORRIS, E. E.	Outflow and Three-Dimensional Spreading of
tion.	Dendrogeomorphic Approach to Measurement	River Water in Enclosed Bay.
W91-11546 5B	of Sedimentation in a Forested Wetland, Black Swamp, Arkansas.	W91-10525 2L
MOOIJMAN, K. A.	W91-11397 2H	MURPHY, I. L.
Production and Control of Reference Materials		Resolving Conflicts on the Danube: The Gabci-
for Water Microbiology.	MORRIS, G. P.	kovo-Nagymaros Power Dam Project.
W91-10623 5A	Occurrence and Viability of Giardia spp. Cysts in UK Waters.	W91-11018 6B
MOORE, P. H. R.	W91-10647 5B	MURTHY, C. R.
Rainfall Interception by Trees of Pinus radiata	MORRIS P	Summer Circulation in the Kingston Basin, Lake
and Eucalyptus viminalis in a 1300 mm Rainfall Area of Southeastern New South Wales: I.	MORRIS, R.  Destruction of Faecal Bacteria, Enteroviruses	Ontario.
Gross Losses and Their Variability.	and Ova of Parasites in Wastewater Sludge by	W91-10978 2H
W91-11345 2D	Aerobic Thermophilic and Anaerobic Mesophi-	MURTY, A. S.
D. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.	lic Digestion.	Standard Test Fish for India and the Neighbor-
Rainfall Interception by Trees of Pinus radiata and Eucalyptus viminalis in a 1300 mm Rainfall	W91-10688 5D	ing Countries.
Area of Southeastern New South Wales: II. In-	EC Bathing Water Virological Standard: Is It	W91-11300 5A
fluence of Wind-Borne Precipitation.	Realistic.	MUSGRAVE, W. F.
W91-11346 2D	W91-10622 5A	Transferability of Water Entitlements in Austra-
MOORE, S. T.	PCR and Environmental Monitoring: The Way	lia.
Agency Autonomy in Transboundary Resource	Forward.	W91-10850 6E
Management: The United States Section of the	W91-10670 5A	NAGEL, R.
International Boundary and Water Commission,	MOTHES, B.	Effect of 3,4-Dichloroaniline on the Early Life
United States and Mexico. W91-11388 6E	Preconcentration of Hydrophilic and Hydropho-	Stages of the Zebrafish (Brachydanio rerio): Re-
	bic Pesticides from Aqueous Solutions and Ex-	sults of a Comparative Laboratory Study.
MORALES-NIN, B.	traction of Residues Using the Polymeric Sor- bent Wofatit Y 77.	W91-10828 5A
Mercury Body Burden and Otolith Characteris- tics of Bluefin Tuna from the Northwest Medi-	W91-11305 5A	NAKADAN, M.
terranean (Balearic Sea).	MOUTTON P	Personal Computer System Supporting Water
W91-10881 2L	MOULTON, R. 1987-89 Drop in Great Lakes Water Levels,	Quality Management in Eutrophicated Bay.
MORAN, D.	Causes and Effect.	W91-10582 5G
Home Water Treatment: Remediating Aldicarb	W91-11023 2H	NAKAGAWA, Y.
Contamination in Suffolk County, New York.	MOUVIER, G.	Numerical Simulation of Water Quality in
W91-11189 5F	Major Ions in Marine Rainwater With Attention	Tokyo Bay.
MORAVEK, M.	to Sources of Alkaline and Acidic Species.	W91-10528 5B
Central Platte Natural Resources District's	W91-11250 5B	NAKAJIMA, M.
Groundwater Management Program.	MUELLER, A.	Change of Oceanic Condition by the Man-Made
W91-11190 5G	Pollutant Transport Monitoring and Prediction	Structure for Upwelling.
MOREIRA, A.	by Mathematical Modelling: North Sea and Ad-	W91-10542 8I
ARCHIMEDES IIa Experiment on Oil Slick	jacent Estuaries. W91-10600 5B	NAKANISHI, H.
Detection over the North Sea-April 1988-		Evaluation of Primary Production Loads and
Measurement Results Obtained by the E-SAR System of the German Aerospace Research Es-	MULDOON, R.	Their Control in Enclosed Seas.
System of the German Aerospace Research Es- tablishment.	Comparison of Pressurized and Gravity Distri- bution Systems for Wastewater Treatment.	W91-10524 5G
W91-10742 5B	W91-10845 5D	NAKAO, M.
		Analysis of Precipitation Chemistry Measure-
MOREIRA-NORDEMANN, L. M. Rainwater and Throughfall Chemistry in a	MULLER, F. L. L. Measurement of the Different Forms of Zinc in	ments in Shimane, Japan.
'Terre Firme' Rain Forest: Central Amazonia.	Narragansett Bay Water Based on the Rate of	W91-10472 2B
W91-11218 2B	Uptake by a Chelating Resin.	NAKATSUJI, K.
MORGAN, G. S.	W91-10926 2K	Outflow and Three-Dimensional Spreading of
Framework for Planning, Monitoring, and Eval-	Voltammetric Determination of the Complexa-	River Water in Enclosed Bay.
uating Watershed Conservation Projects.	tion Parameters of Zinc in Marine and Estuarine	W91-10525 2L
W91-11570 6B	Waters.	NAKOS, G.
MORGENSTERN, N. R.	W91-10924 2K	Budgets of Selected Cations and Anions in Two
Finite-Element Analysis of Softening Effects in	MULLIGAN, F. S.	Forested Experimental Watersheds in Central
Fissured, Overconsolidated Clays and Mud-	Studies on the Environmental Persistence of S-	Greece.
stones. W91-10776 8D	31183 (Pyriproxyfen): Adsorption onto Organic	W91-11550 4C
W91-10776 8D	Matter and Potential for Leaching through Soil. W91-10831 5B	NAMIAS, J.
MORI, T.		Spring and Summer 1988 Drought over the
Observation of the Liquid Water Content of	MUMME, S. P.	Contiguous United States-Causes and Predic- tion.
Melting Snowflakes with a New Instrument. W91-10516 2C	Agency Autonomy in Transboundary Resource Management: The United States Section of the	W91-11412 2B
	grand and a second of the	

NARQUIS, C. Computer Modeling of Scale Formation During Treatment of Ground Water in Air Strippers. W91-10798 5G	NEWHALL, C. G. Snow and Ice Perturbation during Historical Volcanic Eruptions and the Formation of	nology to Enhance Biodegradation of Oil Spills State of the Art and Perspectives for Technolo- gy Development.
	Lahars and Floods. W91-11394 2C	W91-10735 5G
NASCIMENTO, M. J.		NOWAK, P.
Contribution for the Study of New Pathogenic Indicators Removal from W. S. P. in Portugal. W91-10689	NEWMAN, A. T. Avalon Lakes: An Environmental Opportunity. W91-11362 6G	Agrichemicals and Ground Water: Assumptions about Farmer Information Processes.  W91-11163 6B
NASH, K. L.	NEWMAN, P. J.	NURNBERG, G. K.
Synthesis and Decomposition of Novel Organo- phosphorus Complexants. W91-11372 5D	Production, Treatment and Handling of Sewage Sludge.	Phosphorus from Internal Sources in the Lau- rentian Great Lakes, and the Concept of Thresh-
#31-113/2 3D	W91-11116 5D	old External Load.
NASH, P.	NG, R. C.	W91-10982 5B
Production Functions Relating Crop Yield, Water Quality and Quantity, Soil Salintiy and	Framework for Planning, Monitoring, and Eval-	NWADIARO, C.
Drainage Volume.	uating Watershed Conservation Projects. W91-11570 6B	Hydrobiological Survey of the Chanomi Creek
W91-11434 3C	NUMBER COUNTY A	System, Lower Niger Delta, Nigeria. W91-11524 5C
NASR, S. M.	NIELSEN, L. A. Assessing Stream Values: Perspectives of Aquat-	W91-11324 3C
Chemical Composition of the Interstitial Water	ic Resource Professionals.	Proximate Composition and Nutrient Elements
in Bottom Sediments of Tyrrhenian Sea (West-	W91-11425 8I	in the Unusual Algal Jellies of Lake Oguta in
ern Mediterranean): Diagenetic Processes. W91-10880 2J	NIEMI, M.	Southern Nigeria. W91-11408 2H
	Staphylococci in Polluted Waters and in Waters	W91-11408 2H
NATHER KHAN, I. S. A.	of Uninhabited Areas.	NYE, P. H.
Assessment of Water Pollution using Diatom Community Structure and Species Distribution-	W91-10631 5B	Model of Ammonia Volatilization From Applied
A Case Study in a Tropical River Basin.	NIESWAND, G. H.	Urea. V. The Effects of Steady-State Drainage and Evaporation.
W91-11404 5C	Buffer Strips to Protect Water Supply Reser-	W91-10805 3F
NEAL, S.	voirs: A Model and Recommendations.	
Comparison of Pressurized and Gravity Distri-	W91-10816 5G	Model of Ammonia Volatilization From Applied
bution Systems for Wastewater Treatment.	NIEUWSTAD, T. J.	Urea. VI. The Effects of Transient-State Water Evaporation.
W91-10845 5D	F-Specific RNA Bacteriophages as Model Vi-	W91-10806 3F
NEGRI, M. C.	ruses in UV Disinfection of Wastewater.	
Heavy Metal Speciation in Sewage Sludge Fol-	W91-10682 5D	NYMAN, D. J.
lowing a Phyto-Dewatering Treatment.	NIJAMPURKAR, V. N.	Geohydrology and Simulation of Flow in the Chicot Aquifer System of Southwestern Louisi-
W91-11147 5D	Evidence of Chernobyl Fallout on a Temperate	ana.
NEHLSEN, W.	Himalayan Glacier. W91-10950 5B	W91-11100 2F
Pacific Salmon at the Crossroads: Stocks at Risk	W 91-10930	NVCTBOM F
from California, Oregon, Idaho, and Washing- ton.	NILSSON, G. E.	NYSTROM, E.  Trends in Pollution Control In the Swedish Pulp
W91-10834 8I	Decreased Norepinephrine and Epinephrine Contents in Chromaffin Tissue of Rainbow	and Paper Industry.
MELCON E B	Trout (Oncorhynchus mykiss) Exposed to	W91-11469 5G
NELSON, K. R. Graphical Method for Determining the Coeffi-	Diethyldithiocarbamate and Amylxanthate.	O'GRADY, K.
cient of Consolidation cv from a Flow-Pump	W91-10901 5C	What Stakeholders Want and Why.
Permeability Test.	NISHIJIMA, T.	W91-11035 6A
W91-11393 7C	Growth Potentials of Red Tide Phytoplankters	O'NEILL, H. J.
NELSON, S. P.	in Coastal Seawater by AGP Assay.	Transport of the Fungicide Chlorothalonil from
Use of Single-Doppler Radar for Estimating	W91-10548 5A	Its Operational Use on a Pond Ecosystem.
Maximum Hailstone Size. W91-10858 2B	NISHIYAMA, K.	W91-11299 5B
	Meteorology and Oceanography in the Seto	OATFIELD, W. J.
NEUGEBAUER, E. Heavy Metals Contamination in the Polish Zone	Inland Sea. W91-10520 2L	Hydrogeologic Inferences from Drillers' Logs
of Southern Baltic.		and from Gravity and Resistivity Surveys in the
W91-10597 5B	NISS, N. D.	Amargosa Desert, Southern Nevada.
NEVALAINEN, J.	Determination of Selenium Species in Spent Oil Shale Leachates by Ion Chromatography.	W91-10996 5E
Activated Sludge Treatment of Kraft Mill Ef-	W91-11553 5B	OBERLANDER, H.
fluents from Conventional and Oxygen Bleach-	NUMBER A	Preconcentration of Hydrophilic and Hydropho-
ing.	NITTA, A.  Ecological Modelling at Osaka Bay Related to	bic Pesticides from Aqueous Solutions and Ex- traction of Residues Using the Polymeric Sor-
W91-11511 5D	Long-Term Eutrophication.	bent Wofatit Y 77.
NEVES, R. J.	W91-10556 5C	W91-11305 5A
Assessing Stream Values: Perspectives of Aquat-	NOLAN, B. T.	OCTION IN THE
ic Resource Professionals. W91-11425	4 16 Th	OCHS, H. T.  Laboratory Measurements of Small Raindrop
	W91-10486 5G	Distortion. Part I: Axis Ratios and Fall Behav-
NEWCOMBE, C. P. Effects of Suspended Sediments on Aquatic	NOLAN, C. V.	ior.
Ecosystems.	Assimilation of Metals in Marine Copepods and	W91-10513 2B
W91-11426 5C	its Biogeochemical Implications.	ODA, K.
	W91-10866 2L	Succession of Benthic Assemblages in Wild Bird
NEWELL, P. F.  Modification of Benthic Community Structure	NOLEN, S. L.	Park, a Sanctuary Established on Reclaimed
in Response to Acid-Iron Wastes Discharge.	In-Situ Sediment Oxygen Demand in Five	Land in Osaka Port.
W91-10869 5C		W91-10606 2L
NEWELL, R. C.		OETZEL, S.
Modification of Benthic Community Structure	NORDGAARD, E.	Field Experiments with Microbiological Tracers
in Response to Acid-Iron Wastes Discharge. W91-10869 5C	Biotechnology Degradation and Mitigation of Offshore Oil Spills, Phase 1. Main Report: Tech-	in a Pore Aquifer. W91-10673 5E
W91-10869 5C	Change on opins, a mase a mann report. Teen-	

OCATA S	OMATILE	OTT M
OGATA, S.  Investigation on Turbidity and Flow Patterns in	OMATU, S.  Environmental Information Processing of	OTT, M.  Pulsed Field Electrophoresis of Genomic Re-
Half-Closed Sea Area.	Closed Bay Area by Remote Sensing.	striction Fragments for the Detection of Noso-
W91-10532 5B	W91-10581 7B	comial Legionella pneumophila in Hospital Water Supplies.
OGER, C. Interrelations Between Amoebae and Bacteria in	ONAZAKI, O.  Observation of the Liquid Water Content of	W91-10836 5A
the Moselle River, France.	Melting Snowflakes with a New Instrument.	OTTO DESCRIPTION OF
W91-10650 5B	W91-10516 2C	OTTO-WITTE, R.  Influences on the Mechanical Properties of
Miniaturized Fluorogenic Assays for Enumera-	ONI, A. A.	Sewage Sludge for Disposal to Landfill.
tion of E. coli and Enterococci in Marine Water.	Energy Transformation-Ecology Interface from	W91-11135 5D
W91-10639 5A	a Nonlinear, Nonequilibrium Thermodynamic	
OGORODNIKOV, S. P.	Perspective.	OWEN, W. P.
Intake Devices for Dredges with Submersible	W91-11085 5B	Delineation of a Discontinuous Aquitard with Vertical Electrical Soundings, San Bernardino
Suction Pumps.	OOHASHI, T.	Valley, Southern California.
W91-11287 8C	Water Control Systems and the Traditional Fes-	W91-10960 5B
OHGAKI, S.	tival at Miyawaki, on the Seto Inland Sea. W91-10591 3F	OWEN M. E.
Comparative Study on Adsorption Mechanisms		OXLEY, M. E.  Analytical Modeling of Aquifer Decontamina-
of RNA-F-Specific Coliphages and Poliovirus in Activated Sludge Process.	OPPENHUIZEN, M. E. Liquid Chromatographic Determination of Gly-	tion by Pumping When Transport is Affected by
W91-10694 5D	phosate and Aminomethylphosphonic Acid	Rate-Limited Sorption.
OHLINGER, R.	(AMPA) in Environmental Water: Collaborative	W91-11235 5G
Effects of Sewage Sludge and Waste Compost	Study.	OZAKI, E.
on Some Soil Enzymatic Activities Tested in a	W91-11261 5A	Runoff Analysis of the Chang Jiang (The
Field Experiment.	OPRAVILOVA, V.	Yangtze River).
W91-11151 5E	Microzoobenthos of the River Jihlava After the	W91-10966 2E
OHSHIMA, Y.	Construction of the Dalesice Waterworks. W91-11521 6G	PAASSCHENS, C. W. M.
Beneficial Utilization of Incinerated Ash and		Biotechnological Sulphide Removal from Ef-
Melted Slag. W91-11154 5E	ORENIC, C.  Effects of Acid Rain on Epiphytic Orchid	fluents.
	Growth.	W91-11502 5D
OHTSU, I.	W91-11076 5C	PADGITT, S.
Drag on Vertical Sill of Forced Jump. W91-10985 8B	ORIVE, E,	Ground Water Contamination from Agricultural
	Downstream Changes in Caddisfly Composition	Sources: Implications for Voluntary Policy Ad-
OIKARI, A.  Bioavailability of Organic Pollutants in Boreal	and Abundance in Relation to Changes in Water	herence from Iowa and Virginia Farmer's Atti-
Waters with Varying Levels of Dissolved Or-	Conductivity and Oxygen in the River Butron	tudes.
ganic Material.	Basin. W91-11403 5C	W91-11437 5G
W91-10936 5B		PADMANABHAN, G.
OKAICHI, T.	ORR, W. E.	Review of Interbasin Water Transfers with Spe-
Scavenging Processes of Marine Particles in	Abbeystead Outfall Works: Background to Re- pairs and Modifications and Lessons Learned.	cific Attention to Biota.
Osaka Bay. W91-10538 5B	W91-11355 5D	W91-11013 6B
	ORTH, D. J.	PAFFEN, B. G. P.
OKKERMAN, P. C. Ecotoxicological Effects Assessment: A Com-	Habitat Use by an Assemblage of Fish in a Large	Impact of Carbon Dioxide and Ammonium on
parison of Several Extrapolation Procedures.	Warmwater Stream.	the Growth of Submerged Sphagnum cuspida- tum.
W91-10830 5A	W91-11533 2H	W91-11452 2H
OKUMURA, T.	OSTENDORF, D. W.	DATE WOOM C
Sea and Fresh Water Conservation.	Biodegradation of Hydrocarbon Vapors in the Unsaturated Zone.	PAHL-WOSTL, C.  Organization of the Dynamic Network Struc-
W91-10578 5G	W91-11227 5B	ture in the Dimension of Time.
OLDHAM, C. E.		W91-10492 2H
Comparative Inactivation of Hepatitis A Virus	Field Sampling of Residual Aviation Gasoline in Sandy Soil.	BARGALIDOMSH G
and Other Enteroviruses in Water by Iodine. W91-10679 5F	W91-10795 5A	PAISALUDOMSIL, C.  Low Cost Flow Injection Analysis for Cadmium
	OCTEDBY	Using 2-(2-benzothiazolylazo) -4,5-Dimethyl-
OLIVEIRA, J. S.  Contribution for the Study of New Pathogenic	OSTERBY, A.  Measures for Purification of the Leachate from	phenol.
Indicators Removal from W. S. P. in Portugal.	'Renseanlage Damhusaen' into Copenhagen	W91-11379 5A
W91-10689 5D	Waters, to Meet the NPO-Plan.	PAKHMOVA, M. N.
OLIVEIRA, L.	W91-10601 5D	Effect of Hydroelectric Stations on Water Qual-
Contribution for the Study of New Pathogenic	OTA, M.	ity and Development of Phytoplankton in the
Indicators Removal from W. S. P. in Portugal.	Study on Model Reference Adaptive Water Pol-	Lower Pools of Reservoirs.
W91-10689 5D	lution Control in Enclosed Coastal Sea. W91-10567 5G	W91-11289 6G
OLSEN, H. W.		PAL, G. P.
Graphical Method for Determining the Coeffi-	OTSUBO, K.	Production of Chironomid Larvae in Culturing
cient of Consolidation cv from a Flow-Pump Permeability Test.	Field Survey and Hydraulic Study of 'Aoshio' in Tokyo Bay.	Media of Various Organic Wastes.
W91-11393 7C	W91-10529 5C	W91-11526
	OTT, A. N.	PALEOLOG, A.
OLSON, C. M.  Development and Implementation of a Remedial	Assessment of Agricultural Nutrient Point	Coal Mine Waters and Their Influence on the
Investigation Work Plan and Data Management	Source Discharge from Tile Drains, Spring and	Purity Ecological State of River and the Fish
System.	Overland Runoff from Two Farms, Dauphin	Production. W91-10605
W91-10799 5G	County, Pennsylvania. W91-11600 5B	
OLSON, S. R.		PALMATEER, G. A.
Assessment of VAS-Derived Retrievals and Pa- rameters used in Thunderstorm Forecasting.	Nutrient Loading Status of the Conestoga River Basin, 1985-1989.	Coliphage and Bacteriophage as Indicators of Recreational Water Quality.
W91-11423 2B	W91-11599 5G	W91-11334 5A
		JA

5A

PALMER, D. T.	PATTEE, E.	PERALTA, R. C.
Boston's Sewage Outfall. W91-10485 5D	Processing of Leaves of Trees and Aquatic Ma- crophytes in the Network of the River Rhone.	Embedding and Response Matrix Techniques for Maximizing Steady-State Ground-Water Extrac-
PALMER, L. Minnesota Waste Pesticide Collection Pilot	W91-11402 2H	tion; Computational Comparison. W91-10954 2F
Project.	PAUL, J. F. Hazard Assessment Research Strategy for	PERE, J.
W91-11193 5E	Ocean Disposal.	Removal of Acetate from NSSC Sulphite Pulp
PANTELEEV, V. G. Assignment of the Class of Hydraulic-Fill Waste	W91-11551 5E	Mill Condensates Using Thermophilic Bacteria.
Dumps.	PAULSON, A. J.	W91-10889 5D
W91-11285 5E	Remobilization of Cu from Marine Particulate Organic Matter and from Sewage.	PERKINS, M. G.
Characteristics of Mining Quarries on Hydrau-	W91-10923 5B	Optics of Little Sodus Bay. W91-10980 2H
lic-Fill Dumps. W91-11286 8A	PAULSRUD, B.	W 31-10300
	Aerobic Thermophilic Digestion of Pre-Thick-	PERKINS, W. D.
PANUTRAKUL, S. Behavior of Heavy Metals in a Mud Flat of the	ened Sludge Using Air. W91-10704 5D	Radon in Homes Following Its Reduction in a Community Water Supply.
Scheldt Estuary, Belgium.		W91-11464 5B
W91-10872 5B	Alternative Uses of Sludge Other than Agricul- tural.	PERKS, A. R.
PAPADOPOULOS, I.	W91-11120 5E	Hydrometric Data Collection and Interpretation
Trickle Irrigation of Sunflower With Municipal Wastewater.	PAVLETICH, J.	in the Prairie Provinces and Northwest Territo-
W91-11435 3F	Soil Vapor Survey at the LLNL Site 300 Gener-	ries.
PAPPAJOHN, J. G.	al Services Area, Adjacent Portions of the Con-	W91-11278 7A
Design of Economic and Efficient Treatment	nolly and Gallo Ranches and the Site 300 Land- fill Pit 6 Area.	PERRY, C. A.
Station for Acidic Streams.	W91-10747 5B	Planned Studies of Agrichemicals in Ground
W91-11077 5G		and Surface Water in the Mid-Continental
PAQUETTE, J.	PAYMENT, P. Elimination of Coliphages, Clostridium perfrin-	United States. W91-11168 5B
September 5, 1987, Landslide on the La Grande	gens and Human Enteric Viruses During Drink-	W91-11108
River, James Bay, Quebec, Canada. W91-10946 2J	ing Water Treatment: Results of Large Volume	PERRY, W. J.
	Samplings. W91-10654 5F	NOAA Satellite Data in Natural Oil Slick De-
PARK, S. K.  Delineation of a Discontinuous Aquitard with	W91-10654 5F	tection, Otway Basin, Southern Australia. W91-11296 5A
Vertical Electrical Soundings, San Bernardino	Prospective Epidemiological Study of Drinking	
Valley, Southern California.	Water Related Gastrointestinal Illnesses. W91-10618 5B	PERSSON, J. A.
W91-10960 5B		Determination of Trace Levels of Sulphate in Water Using Flow-Injection and In-Line Pre-
PARKER, D. S.	PAYNE, J. R. Brine-Induced Advection of Dissolved Aromat-	concentration.
Case for Circular Clarifiers. W91-11224 5D	ic Hydrocarbons to Arctic Bottom Waters.	W91-11246 2K
W91-11224	W91-11340 5B	PERTTULA, M.
PARKER, G. G.	PEARCE, R. J.	Removal of Acetate from NSSC Sulphite Pulp
Piping and Pseudokarst in Drylands. W91-11561 2F	Management of the Marine Environment in	Mill Condensates Using Thermophilic Bacteria.
	Western Australia: An Ecosystem Approach.	W91-10889 5D
PARKER, J. F. W. Occurrence of Cryptosporidium spp. Oocysts in	W91-10583 5G	PESCH, G. G.
Scottish Waters, and the Development of a	PEARSON, A. D.	Application of a Hazard Assessment Research
Fluorogenic Viability Assay for Individual	Latex Agglutination for the Detection of Cam-	Strategy to the Ocean Disposal of a Dredged
Cryptosporidium Oocysts. W91-10645 5B	pylobacter Species in Water. W91-11465 5A	Material: Overview. W91-10740 5E
PARROTTA, M. J.	PECHNEANU, I.	
Radioactivity in Water Treatment Wastes: A	Present State of Environmental Pollution in	PESSOA, G. V. A.
USEPA Perspective.	Coastal Sea Area and Measures for Protection.	Occurrence of V. cholerae 0:1 Non-Toxigenic in Wastewaters from Sao Paulo, Brazil.
W91-11461 5B	W91-10540 5B	W91-10685 5D
PARRY, M. L.	PEKAU, O. A.	DETER D
Climatic Change and Future Agroclimatic Po- tential in Europe.	Seismic Fracture Analysis of Concrete Gravity	PETER, R.  Minnesota's Olmsted County: A Cooperative
W91-10970 2B	Dams. W91-10787 8F	Health Based Perspective on Zoning and Plan-
PARSONS, D. F.		ning.
Fluctuating Great Lakes Water Levels: Progress	PELL, E. J.  Effects of Drought Stress and Simulated Acidic	W91-11187 6E
and Opportunities.	Rain on Foliar Conductance of Zea mays L.	PETERS, N. E.
W91-11032 6A	W91-10919 5C	
PARVOLI, G. Use of 2,2-Dimethoxypropane for the Direct	PELLINEN, J.	Alpine Watershed in Sequoia National Park California, to Acidification during Snowmelt by
Gas Chromatographic-Mass Spectrometric De-	Onset of Lignin-Modifying Enzymes, Decrease	Using a Simple Hydrochemical Model.
termination of Some Organic Compounds in	of AOX and Color Removal by White-Rot	W91-11594 5C
Water. W91-11245 5A	Fungi Grown on Bleach Plant Effluents. W91-11487 5D	Executive Summary-Assessing the Response of
		Emerald Lake, An Alpine Watershed in Sequois
PATARNELLO, T.	PENG, T. H.  Atmospheric Carbon Dioxide and the Global	National Park, California, to Acidification
Effects of Pollution on Heterozygosity in the Barnacle Balanus amphitrite (Cirripedia: Thora-	Carbon Cycle: The Key Uncertainties.	cal Model
cica).	W91-11068 5B	W91-11112 70
W91-10518 5C	PENTECOST, A.	
PATRICK, R.	Identity of Suspended Particles in a Calcite-	
Past, Present, and Future of Water Use and	Depositing Stream and Their Significance in Trapping and Binding Phenomena.	Analysis of Halogenated Acetic Acids in Dutch Drinking Water.
Management. W91-11209 4A		

## PETERSON, B. J.

PETERSON, B. J. Role of Seasonal Turnover in Lake Alkalinity Dynamics. W91-10861 2H	PINOL, J. Hydrological Balance of Two Mediterranean Forested Catchments (Prades, Northeast Spain).	POSTON, T. M. Estimation of Sport Fish Harvest for Risk and Hazard Assessment of Environmental Contami-
W91-10861 2H	W91-10963 2A	nants.
PETERSON, T. C.	PITT, R. E.	W91-11556 5G
Effect of Decoupled Low-Level Flow on Winter Orographic Clouds and Precipitation in	Urban Storm-Induced Discharge Impacts.	POTTER, C. S.
the Yampa River Valley.	W91-10745 5B	Dry Deposition Washoff from Forest Tree
W91-11410 2B	PLASSCHE, E. J.	Leaves by Experimental Acid Rainfall.
	Ecotoxicological Effects Assessment: A Com-	W91-10476 5B
PETRUZZELLI, G.	parison of Several Extrapolation Procedures.	POULTON, M.
Heavy Metal Speciation in Sewage Sludge Fol-	W91-10830 5A	Thames Water's Experiences with Cryptospori-
lowing a Phyto-Dewatering Treatment. W91-11147 5D	BE ATON N. I	dium.
W91-11147 5D	PLATOV, V. I.  Operating Experience and Suggestions on Re-	W91-10617 5C
PETTERSEN, B. W.	construction of the Turbines of the Dnepr-I Hy-	
Measures for Purification of the Leachate from	droelectric Station.	POWELL, J.
'Renseanlaeg Damhusaen' into Copenhagen	W91-11290 8C	Iterative Evaluation of a Lake Water Quality
Waters, to Meet the NPO-Plan.		Management Program.
W91-10601 5D	PLUMB, R. H.	W91-10808 5G
PETTY, R. J.	Occurrence of Appendix IX Organic Constitu-	Willingness-to-Pay for Protection of Water Sup-
Application of the DRASTIC Mapping System	ents in Disposal Site Ground Water. W91-10801 5B	plies in Four Massachusetts' Towns.
for Evaluating Ground Water Pollution Poten-	W91-10801 3B	W91-11056 6C
tial in Ohio.	POGGIO, G.	
W91-11178 5B	Modifications of Some Physical Properties in	POWERS, C. R.
PETZOLDT, C.	Two Compost-Amended Italian Soils.	Determination of Selenium Species in Spent Oil
Funding New York State's Integrated Pest Man-	W91-11148 5E	Shale Leachates by Ion Chromatography.
agement Program.	POMARES, F.	W91-11553 5B
W91-11180 6C	Chemical Properties of Sewage Sludges Pro-	POWERS, S. E.
DIMENTING C D	duced in the Valencian Area (Spain).	Theoretical Study of the Significance of None-
PHILLIPS, S. P. Calibration of a Texture-Based Model of a	W91-11159 5A	quilibrium Dissolution of Nonaqueous Phase
Ground-Water Flow System, Western San Joa-		Liquids in Subsurface Systems.
quin Valley, California.	POMMEPUY, M.	W91-11228 5B
W91-11101 5B	Salmonella Detection in Sewage Waters Using	
	Fluorescent Antibodies.	POWLEY, R. L.
PHINNEY, R. B.	W91-10687 5D	Flow Through Gated Conduits at Partial and
Effects of Changes in Land Use on Annual	POOK, E. W.	Full Gate Openings.
Streamflows in the Lake Huron Basin of Canada and the United States.	Rainfall Interception by Trees of Pinus radiata	W91-11276 8C
W91-11021 4C	and Eucalyptus viminalis in a 1300 mm Rainfall	POZNYAK, S. P.
	Area of Southeastern New South Wales: I.	Physical Properties of Irrigated Chernozems of
PIENAAR, E. J.	Gross Losses and Their Variability.	the Southern Ukraine.
Occurrence of Legionella Bacteria in Cooling	W91-11345 2D	W91-10915 2G
Towers in South Africa. W91-10641 5B	Rainfall Interception by Trees of Pinus radiata	
W 91-10041 3B	and Eucalyptus viminalis in a 1300 mm Rainfall	PRANDLE, D.
PIERSON, F. B.	Area of Southeastern New South Wales: II. In-	5-Year Scientific Research Programme for Managing Coastal Seas.
Spatial and Temporal Influence of Soil Frost on	fluence of Wind-Borne Precipitation.	W91-10531 2L
Infiltration and Erosion of Sagebrush Range-	W91-11346 2D	W71-10551
lands. W91-10820 2G	POPP, W.	PRASANTHI DHARMAPPA, H.
W 91-10020 2G	UV Disinfection of Secondary Effluents from	Use of a Backflush Technique in Cross-flow
PIGG, J.	Sewage Treatment Plants.	Microfiltration for Treating Natural Water and
Upstream Extirpation of Four Minnow Species	W91-10681 5D	Filter Backwash Wastewater in Water Works.
Due to Damming of a Prairie Stream.	PORCALOVA B	W91-11270 5F
W91-11535 6G	PORCALOVA, P. Phosphorus Losses from the Epilimnion in	PRAVDIC, V.
PIGRAM, J. J.	Rimov Reservoir.	Conceptual Framework of Environmental Man-
Transferability of Water Entitlements in Austra-	W91-11401 2H	agement Strategies for Yugoslavia: The Case of
lia.		the Adriatic Sea.
W91-10850 6E	PORCH, W. M.	W91-10584 5G
PIKE, E. B.	Comparison of Nocturnal Drainage Flow in	PRETOCI ED A M
Destruction of Faecal Bacteria, Enteroviruses	Three Tributaries. W91-10501 2E	PREISSLER, A. M.
and Ova of Parasites in Wastewater Sludge by	W 22-10301	Geochemical Evolution of Ground Water in Smith Creek Valley-A Hydrologically Closed
Aerobic Thermophilic and Anaerobic Mesophi-	PORTER, J. H.	Basin in Central Nevada, U.S.A.
lic Digestion.	Climatic Change and Future Agroclimatic Po-	W91-11392 2K
W91-10688 5D	tential in Europe.	
PILARCZYK, K.	W91-10970 2B	PREMAZZI, G.
Investigation of Local Scour in Cohesionless	PORTER, J. P.	Delay in Lake Recovery Caused by Internal
Sediments Using a Tunnel-Model.	RUSLE: Revised Universal Soil Loss Equation.	Loading.
W91-10746 2J	W91-10510 2J	W91-10886 2H
	PORTERIES D. I	PREMUZIC, E. T.
PINDER, G.	PORTERFIELD, J.	Role of Biotechnology in the Treatment of Geo-
Optimal Data Acquisition Strategy for the De- velopment of a Transport Model for Ground-	Farm Bureau's Groundwater and Environmental Ouality Self-Help Checklist for Farmsteads and	thermal Residual Sludges.
water Remediation.	Farm Fields.	W91-10744 5D
W91-11238 5G	W91-11201 5G	
		PRESTON, D. R.
PINI, R.	POST, W. M.	Adsorption of Viruses by Diatomaceous Earth
Modifications of Some Physical Properties in	Atmospheric Carbon Dioxide and the Global	Coated with Metallic Oxides and Metallic Per-
Two Compost-Amended Italian Soils. W91-11148 5E	Carbon Cycle: The Key Uncertainties. W91-11068 5B	oxides. W91-10659 5A
7711140 JE	77 7 1 1 0 0 0 JB	W91-10659 5A

PREVOT, J.	RAJARATNAM, N.	RASTOGI, A. K.
Detection of Hepatitis A Virus and Other Enter- oviruses in Wastewater and Surface Water Sam- ples by Gene Probe Assay.	Hydraulics of Culvert Fishways IV: Spoiler Baffle Culvert Fishways. W91-11279 8I	Computation of Average Seasonal Groundwater Flows in Phreatic Aquifer-River System. W91-10910 2F
W91-10665 5A		
PRINSLOO, N.	RAJU, J. Simple Spectrophotometric Determination of	RATHBONE, P. A.
Assessment of Methods for the Microbiological Analysis of Shellfish.	Endosulfan in River Water and Soil. W91-11314 5A	Impact of Titanium Dioxide Waste on Fertiliza- tion in the Sea Urchin Echinometra mathaei. W91-10870 5C
W91-10695 5A	RALLO, A.	RATHBUN, R. E.
PROFT, G. Chemical Composition of Late- and Post-Glacial Sediments (Fe, Mn, P, C, N, N, H and BSi) in Lake Kleiner Barsch-See, a Bog Lake in the	Morphology and Quantitative Analysis of Fluvi- al Erosion Systems in the Hydrological Network of the Basque Country Autonomous Region. W91-11265	Fate of Acetone in an Outdoor Model Stream with a Nitrate Supplement, Southern Mississippi, U.S.A. W91-10903 5B
North of GDR (Die Chemische Zusammenset- zung der Spat- und Postglazialsedimente des Kleinen Barsch-Sees (Fe, Mn, P, C, N, H und	RAMAMURTHY, M. H. Dynamical Forcing and Mesoscale Organization	Transport and Fate of Acetone in an Outdoor Model Stream, Stennis Space Center near Bay
BSi), eines Dystrophen Moorweihers im Norden der DDR).	of Precipitation Bands in a Midwest Winter Cyclonic Storm. W91-11424 2B	St. Louis, Mississippi. W91-11103 5B
W91-11518 2H	RAMAMURTHY, V. D.	RATHORE, H. P. S.
PUHAKKA, J. A. Oxic Fluidized-Bed Treatment of Dichlorophen- ols.	Effects of Oil Pollution on Bio-Ecology and Fisheries on Certain Enclosed Coastal Regions	Spectrophotometric Determination of Nitrite in Polluted Waters Using 3-Nitroaniline.
W91-11485 5D	of Arabian Sea. W91-10555 5B	W91-10823 5A
DITC W		RATZA, C. A.
PULS, W. Pollutant Transport Monitoring and Prediction by Mathematical Modelling: North Sea and Ad-	RAMANATHAN, A. L.  Heavy Metal Distribution in the Godvari River Basin.	Cooperative Data on Regional Water Use: The Great Lakes Regional Water Use Data Reposi- tory.
jacent Estuaries. W91-10600 5B	W91-11445 5B	W91-11010 6D
	RAMANI, G. M. A.	RAUBER, R. M.
QUENNELL, S.  Efficiency of an Ozoflotation-Filtration Process for the Treatment of the River Thames at Walton Works.	Seasonal Variations and Relationships of Different Physico-chemical Characteristics in Newly Made Tawa Reservoir. W91-11528 2H	Dynamical Forcing and Mesoscale Organization of Precipitation Bands in a Midwest Winter Cyclonic Storm.
W91-11268 5F	W91-11528 2H	W91-11424 2B
OUEVALIVITY ED D	RAMBAUD, A.	RAYMO, M. E.
QUEVAUVILLER, P. Organotin Stability During Storage of Marine Waters and Sediments. W91-11255 5A	Deforestation and Leaching of Nitrogen as Ni- trates into Underground Water in Intertropical Zones: The Example of Cote d'Ivoire. W91-11446 2F	Geochemical Evidence Supporting T. C. Chamberlin's Theory of Glaciation.  W91-10790 2C
	W91-11440 2F	
QUINN, F. Will Free Trade Drink Canada Dry. W91-11041 6D	RAND, P. W.  Radon in Homes Following Its Reduction in a  Community Water Supply.	RAYMOND, J. R.  Relationship of Regional Water Quality to Aqui- fer Thermal Energy Storage.
	W91-11464 5B	W91-11082 5C
QURESHI, A. A. Polyvalent Coliphages in Sewage. W91-10663 5A	RANGANNA, G. Studies on Assessment of Water Balance and Its	REED, J. R.  Toxicity Reduction Evaluations (TRE's) As a
QURESHI, M. A.	Quality in Gurpur River Basin, Karnataka State,	Tool for Meeting Effluent Standards.
Polyvalent Coliphages in Sewage.	India. W91-11065 5B	W91-11542 6E
W91-10663 5A		REED, R.
RADHAKRISHNAIAH, K. Assessment of Mercury Toxicity by the Changes	RANGO, A.  Water Supply Implication of Climate Change in Western North American Basins.	Health Risk Assessment of Toluene in California Drinking Water. W91-10741 5C
in Oxygen Consumption and Ion Levels in the	W91-11059 2B	W91-10741 5C
Freshwater Snail, Pila globosa, and the Mussel,	RANKL, J. G.	REED, W.
Lamellidens marginalis. W91-11304 5C	Point-Infiltration Model for Estimating Runoff from Rainfall on Small Basins in Semiarid Areas	Health Risk Assessment of Toluene in California Drinking Water. W91-10741 5C
RADWAN, S.  Coal Mine Waters and Their Influence on the	of Wyoming. W91-11585 2E	
Purity Ecological State of River and the Fish	W91-11363	REES, T. F. Use of a Single-Bowl Continuous-Flow Centri-
Production. W91-10605 5B	RANTALA, P. R.  Activated Sludge Treatment of Kraft Mill Effluents from Conventional and Oxygen Bleach-	fuge for Dewatering Suspended Sediments: Effect on Sediment Physical and Chemical
RAGO, P. J.	ing.	Characteristics.
Species Composition of Fish Communities in Northern Wisconsin Lakes: Relation to pH.	W91-11511 5D RANVILLE, J. F.	W91-11350 7B REEVE, D. E.
W91-10725 5C	Use of a Single-Bowl Continuous-Flow Centri-	Simulation of Bioecological and Water Quality
RAGONE, S. E. Planned Studies of Agrichemicals in Ground	fuge for Dewatering Suspended Sediments: Effect on Sediment Physical and Chemical	Processes in Enclosed Coastal Seas. W91-10557 5C
and Surface Water in the Mid-Continental United States. W91-11168 5B	Characteristics. W91-11350 7B	REICHERT, B.  Application of Microbial Tracers in Groundwat-
	RAO, D. K.	er Studies. W91-10671 5B
RAGSDALE, H. L.  Dry Deposition Washoff from Forest Tree	Evidence of Chernobyl Fallout on a Temperate Himalayan Glacier.	W91-10671 5B
Leaves by Experimental Acid Rainfall. W91-10476 5B	W91-10950 5B	Field Experiments with Microbiological Tracers in a Pore Aquifer.
	RAO, S. M. Mechanistic Evaluation of Mitigation of Petrole-	W91-10673 5B
RAHMAN, M. Computation of Uniform Flow in Open Chan-	um Hydrocarbon Contamination by Soil	REINCKE, H.
nels with Flood Plains.	Medium.	Chemolysis Process of Dow Stade GMBH. W91-11144 5D
W91-11281 2E	W91-10779 5G	W91-11144 5D

## REINCKE, H.

Sludge Reduction Possibilities as Demonstrated by the Chemolysis Process Dow Stade GmbH. W91-11118 5D	RIDGLEY, S. M. Urban Pesticide Waste Management: Strategies for Education and Collection. W91-11194 5E	ROBERTS, P. J. W. Surface Dilution of Round Submerged Buoyant Jets. 1001-1006
RENARD, K. G. RUSLE: Revised Universal Soil Loss Equation.	W91-11194 5E RIEDEL, G. F.	W91-10986 5E ROBERTSON, G.
W91-10510 2J	Pathways of Silver Uptake and Trophic Trans- fer in Estuarine Organisms.	Coefficient of Pollution (p): The Southern Cali- fornia Shelf and Some Ocean Outfalls.
RENN, D. E.  Description of the Physical Environment and	W91-11337 5B	W91-10874 5B
Coal-Mining History of West-Central Indiana,	RIGGS, H. C.	ROBINSON, C. T.
with Emphasis on Six Small Watersheds. W91-11576 2E	Estimating Flow Characteristics at Ungauged Sites.	Longitudinal Development of Macroinverte- brate Communities Below Oligotrophic Lake
RENZETTI, S.	W91-11545 2E	Outlets.
Costs and Benefits of Moving to Peak-Load	RIGON, R.	W91-10856 2H
Pricing for Municipally-Supplied Water. W91-11047 6C	Geomorphological Dispersion. W91-11232 2E	ROBINSON, D. A. Cloud/Cryosphere Interactions.
REY, J. R.	RINALDO, A.	W91-11095 2B
Wetland Impoundments of East-Central Florida. W91-10854 2L	Geomorphological Dispersion.	ROCA, J.
REYNOLDS, R. J.	W91-11232 2E	Chemical Properties of Sewage Sludges Pro- duced in the Valencian Area (Spain).
Availability of Ground Water from Unconsoli-	RINTALA, J.  Future Perspectives for the Anaerobic Treat-	W91-11159 5A
dated Deposits in the Mohawk River Basin, New York.	ment of Forest Industry Wastewaters.	RODHE, H.
W91-11104 2F	W91-11478 5D	Zonal Average Cloud Characteristics for Global Atmospheric Chemistry Modelling.
Hydrogeology of the Valley-Fill Aquifer at	Thermophilic Anaerobic Treatment of Sulfate- Rich Pulp and Paper Integrate Process Water.	W91-10728 2B
Owego, Tioga County, New York. W91-11105 2F	W91-11483 5D	RODRIGUEZ-MAROTO, J. M.
	RITCHIE, J. C.	Soil Clean Up by In-situ Aeration: VI. Effects of
REZNIKOVSKII, A. S. Method of Compiling Water-Management Bal-	Relationship of MSS and TM Digital Data with Suspended Sediments, Chlorophyll, and Tem-	Variable Permeabilities. W91-11317 5G
ances. W91-11293 2A	perature in Moon Lake, Mississippi.	ROELOFS, J. G. M.
	W91-11354 7C	Impact of Carbon Dioxide and Ammonium on
RHEAUME, S. J. Geohydrology and Water Quality of Kalamazoo	RIVERA, G.  Aerobic and Anaerobic Biofiltration in an Aqua-	the Growth of Submerged Sphagnum cuspida- tum.
County, Michigan, 1986-88. W91-11091 2F	culture UnitNitrite Accumulation as a Result	W91-11452 2H
RHOADES, J. D.	of Nitrification and Denitrification. W91-11547 5D	ROGERS, D. C.
Production Functions Relating Crop Yield,	RIVERS, R.	Effect of Decoupled Low-Level Flow on Winter Orographic Clouds and Precipitation in
Water Quality and Quantity, Soil Salintiy and Drainage Volume.	Industrial Water Pricing for Ontario: Towards	the Yampa River Valley.
W91-11434 3C	Realistic Pricing. W91-11048 6C	W91-11410 2B
RHODES, N. R.	Socio-Economic Considerations in Remedial	ROMANO, F. Composting Raw Sewage Sludge in the Absence
Characterization of Radioactivity in Hot Springs National Park, Arkansas.	Action Planning for the Great Lakes-A Case	of Bulking Agents.
W91-10846 2K	Study for Sustainable Development. W91-11031 6A	W91-11149 5E
RIAZ, R. A.	ROADCAP, G. S.	ROMER, R. Sewage Sludge Incineration and Utilization of
Development of Small Hydro for Remote Areas of Northern Pakistan.	Delineation of Traveltime-Related Capture	Energy.
W91-11215 8C	Areas of Wells Using Analytical Flow Models and Particle-Tracking Analysis.	W91-11131 5D
RICHARDS, P.	W91-10957 2F	ROMERO, P.
Socio-Economic Impact of Improved Wells in Rural Sierra Leone.	ROBEL, W.	Relationship Between Pseudomonas aeruginosa and Bacterial Indicators in Polluted Natural
W91-11358 6B	Environmental Aspects of Sludge Incineration: Overview.	Waters. W91-10635 5A
RICHARDSON, D. A.	W91-11130 5E	
Anaerobic Toxicity of Fines In Chemi-thermo- mechanical Pulp Wastewaters: A Batch Assay-	ROBERGE, J.	ROMM, J.  Groundwater Depletion in India: Institutional
Reactor Study Comparison.	Subice Layering and Origin of Acidic Waters in a Small Boreal Lake During the Spring Runoff.	Management Regimes. W91-11382 4B
W91-11479 5D	W91-11229 5B	
RICHARDSON, L. Prospective Epidemiological Study of Drinking	ROBERT, P. C.	ROOLJMANS, P. J. Sludge Dewatering: First Membrane Filterpress
Water Related Gastrointestinal Illnesses.	Soil Survey Information System: A User Friend- ly Soil Information System.	Plant in the Netherlands Operational. W91-11155 5D
W91-10618 5B	W91-11174 7C	
RICKERT, P. G.  Application of Supported Liquid Membranes for	ROBERTS, E. A.	ROOM, P. M. Temperatures Lethal to Salvinia molesta Mitch-
Removal of Uranium From Groundwater.	Effect of Three Primary Treatment Sewage Outfalls on Metal Concentrations in the Fish	ell.
W91-11370 5G	Cheilodactylus fuscus Collected Along the	
Synthesis and Decomposition of Novel Organo- phosphorus Complexants.	Coast of Sydney, Australia. W91-10873 5B	ROOS, H. J.  Aerobic-Thermophilic Methods for Disinfecting
W91-11372 5D	ROBERTS, E. V.	and Stabilizing Sludge.
RICO, E.	Dynamics of Pesticides in Tropical Conditions.	W91-11143 5D
Morphology and Quantitative Analysis of Fluvi- al Erosion Systems in the Hydrological Network	<ol> <li>Kinetic Studies of Volatilization, Hydrolysis, and Photolysis of Dieldrin and Alpha and Beta</li> </ol>	ROSE, J. B. Use of Risk Assessment for Development of
of the Basque Country Autonomous Region.	Endosulfan.	Microbial Standards.
W91-11265 2J	W91-11375 5B	W91-10619 5G

ROSE, M. R. Assessment of the Salinity Tolerance of Eight Sonoran Desert Riparian Trees and Shrubs. W91-10752 3C	RUS, E. Biodegradation of Benzene and a BTX Mixture Using Immobilized Activated Sludge. W91-11381 5D	SAMI, K.  Comparison of Measured and Estimated Unsaturated Hydraulic Conductivities During Snowmelt.
ROSEN, B. Conductivity for Nutrient Control In CTMP	RUSHTON, K. R. Soil Water Dynamics Related to Waterlogging	W91-10904 2G SAMSON, R.
Wastewater Treatment. W91-11495 5D	in a Sloping Catchment. W91-10906 2G	Effect of NSSC Spent Liquor on Granule For- mation and Specific Microbial Activities In
ROSENBERG, P. September 5, 1987, Landslide on the La Grande River, James Bay, Quebec, Canada.	RUSSELL, J. P.  Hydrogeology, Water Quality, and Ground- Water Development Alternatives in the Lower	Upflow Anaerobic Reactors. W91-11482 5D
W91-10946 2J	Wood River Ground-Water Reservoir, Rhode Island.	SANCHEZ, P. S. Occurrence of V. cholerae 0:1 Non-Toxigenic in
ROSENTHAL, A.  Permitting Nonpoint Sources: Programs, Provisions, Problems and Potential.	W91-11572 2F RUST, W. D.	Wastewaters from Sao Paulo, Brazil. W91-10685 5D
W91-10730 5G	Electrical and Kinematic Structure of the Strati- form Precipitation Region Trailing an Oklahoma	SANDERS, J. G. Pathways of Silver Uptake and Trophic Trans-
ROSER, D. J. Incidence of Legionella in the Urban Environ- ment in Australia.	Squall Line. W91-10514 2B	fer in Estuarine Organisms. W91-11337 5B
W91-10929 5B	SABATINI, D. A. Characteristics of Rhodamine WT and Fluores-	SANDGREN, K. R. Removal of Heavy Metals and Other Cations
ROSSI, G. Delay in Lake Recovery Caused by Internal	cein as Adsorbing Ground-Water Tracers. W91-10952 5B	From Wastewater Using Zeolites. W91-11369 5D
Loading. W91-10886 2H	SABRI, A. W.	SANFORD, W. E.
ROSSOW, W. B. ESCCP Cloud Data Products.	Local and Seasonal Variation of the Epipelic Algae in Samarra Impoundment, Iraq. W91-11525 2H	Ground-Water Control of Evaporite Deposition. W91-11438 2K
W91-10479 2B	SAEKI, K.	SANZ MARTIN, J. L.
ROTHHAUPT, K. O.  Alternating Dynamics of Rotifers and Daphnia magna in a Shallow Lake.	Eutrophication Mechanisms of Coastal Seas in Yamaguchi Prefecture. W91-10593 5B	Thermophilic Anaerobic Treatment of Sulfate- Rich Pulp and Paper Integrate Process Water. W91-11483 5D
W91-10898 2H	SAIKA, M.	SARIKELLE, S.
ROWE, R. K. Analysis of Three-Dimensional Ground Move-	Production of Compost from Sewage Sludge in Tokyo.	Analysis of Large Scale Water Distribution Systems.
ments: The Thunder Bay Tunnel. W91-10775 8A	W91-11153 5E	W91-10983 5F
ROY, P. Social and Private Returns from Wetland Pres- ervation. W91-11057 5G	SAINT-FORT, R. Groundwater Contamination By Anthropogenic Organic Compounds From Waste Disposal Sites: Transformations and Behavior.	SARNAIK, S. Activated Sludge Process to Reduce the Pollu- tion Load of a Dye-Industry Waste. W91-11455 5D
ROY, S. P.	W91-11378 5B	SARTOR, J.
Wellhead Protection-Information and Resources. W91-11172 5G	SAITO, T. Observation of the Liquid Water Content of Melting Snowflakes with a New Instrument. W91-10516 2C	New Storm Water Regulations Require Signifi- cant Compliance Actions by Both Industries and Municipalities. W91-11541 5D
RUDDICK, B. R. Reactive Continuum Representation of Organic	SAJUS, J.	SARTORL F.
Matter Diagenesis. W91-11448 2J	Nitrate Removal by Denitrification in Alluvial Ground Water: Role of a Former Channel. W91-10909 5B	Trace Element Distribution in Surficial Sedi- ments of the Northern Tyrrhenian Sea: Contri-
RUDOLPH, K. U. Environmental Aspects of Sludge Incineration:	SAKAMOTO, I.	bution to Heavy-Metal Pollution Assessment. W91-11444 5A
Overview. W91-11130 5E	Use of Respiration in the Sandy Beach or on the Tidal Flat: 1. Permeable Sandy Beach. W91-10541 5G	SASINUS, F. I.
RUKAVINA, N.	SAKELLARIS. M. G.	and Ester Herbicides in Soil and Water by Liquid Chromatography Particle Beam Mass
Acoustic Parametric Array for Measuring the Thickness and Stratigraphy of Contaminated Sediments. W91-10981 2J	Coliphage and Bacteriophage as Indicators of Recreational Water Quality. W91-11334 5A	Spectrometry and Ultraviolet Absorption Spec- trophotometry.
W91-10981 2J RULAND, W. W.	SALAS, H. J.	SASYO, Y.
Depth of Fractures and Active Ground-Water Flow in a Clayey Till Plain in Southwestern	Simplified Phosphorus Trophic State Model for Warm-Water Tropical Lakes.	Observation of the Liquid Water Content of Melting Snowflakes with a New Instrument.
Ontario. W91-10959 2F	W91-11332 5C	W91-10516 2C
RULKENS, W. H. Removal of Heavy Metals from Sewage Sludge:	SALIBA, L. J.  Public Health Criteria for the Aquatic Environment: Recent WHO Guidelines and Their Appli-	
State of the Art and Perspectives. W91-11124 5D	cation. W91-10620 5G	W01 11291 2E
RUNGE, K.	SALIOT, A.	SATO, M. I. Z. Occurrence of V. cholerae 0:1 Non-Toxigenic in
Some Updated Statistical Assessments of the Surface Temperature Response to Increased Greenhouse Gases.	Fluxes and Transport of Anthropogenic and Natural Polycyclic Aromatic Hydrocarbons in the Western Mediterranean Sea.	
W91-10969 2B		SATOH, H.
RUONALA, S.	SALKINOJA-SALONEN, M.	Seasonal Changes of Organic Carbon and Nitro
Trends In Water Pollution Control In the Finn- ish Pulp and Paper Industry.	Biodegradability of Chlorinated Organic Com- pounds In Pulp Bleaching Effluents.	<ul> <li>gen Production by Phytoplankton in the Estuary of River Tamagawa.</li> </ul>
W91-11468 5G		

SATTLER, P. J. Numerical Modelling of Vertical Ground Move-	SCHICK, A. P. Distance of Movement of Coarse Particles in	SCHRADER, E. L. Remediation of Floating, Open Water Oil Spills:
ments in Expansive Soils. W91-10945 2G	Gravel Bed Streams. W91-11231 2J	Comparative Efficacy of Commercially Avail- able Polypropylene Sorbent Booms.
SAUER, S. P.	SCHIEBE, F. R.	W91-11447 5G
Report of the River Master of the Delaware River, for the Period December 1, 1988-Novem-	Relationship of MSS and TM Digital Data with Suspended Sediments, Chlorophyll, and Tem-	SCHRAMM, K. W. Determination of Effective Diffusion Coeffi-
ber 30, 1989.	perature in Moon Lake, Mississippi. W91-11354 7C	cients for Gaseous and Dissolved Organic Sub-
W91-10765 4A		stances in Soil Material Using a 'Stopped Elu- tion' Method with HPLC and GC.
SAUNAMAKI, R.	SCHIFFER, R. A. ESCCP Cloud Data Products.	W91-10802 7B
Factors Affecting the Removal and Discharge of Organic Chlorine Compounds at Activated	W91-10479 2B	SCHRODER, C.
Sludge Treatment Plants.	SCHIJVEN, J. F.	Rotifers of the Genus SynchaetaAn Important
W91-11498 5D	Virological Quality of Recreational Waters in	Component of the Zooplankton in the Coastal
SAVENHED, R.	the Netherlands. W91-10653 5B	Waters of the Southern Baltic. W91-11519 2L
Organohalogens of Natural and Industrial Origin		
In Large Recipients of Bleach-Plant Effluents. W91-11505 5B	SCHINDLER, P. R. G.	SCHULLERER, S. Strategy for Pesticide Control in Ground Water
	Coliform Bacteria in Drinking Water from South Bavaria: Identification by the API 20E-	and Drinking Water.
SAVOLAINEN, M. Factors Affecting the Removal and Discharge	System and Resistance Patterns.	W91-11312 5A
of Organic Chlorine Compounds at Activated	W91-10627 5F	SCHULTE, M.
Sludge Treatment Plants. W91-11498 5D	SCHLETT, C.	Microclimatological Investigations in the Tropi-
	Multi-Residue-Analysis of Pesticides by HPLC after Solid Phase Extraction.	cal Alpine Scrub of Maui, Hawaii: Evidence for a Drought-Induced Alpine Timberline.
SAXENA, V. K.  Interannual Variability in Acidic Deposition on	W91-11307 5A	W91-10878 2I
the Mt. Mitchell Area Forest.	SCHLOSSER, I. J.	SCHILL TE BORDECKE D
W91-10478 5B	Short-Term Effects of a Catastrophic Beaver	SCHULZE-ROBBECKE, R.  Growth and Inactivation Kinetics of Mycobac-
SCAMEHORN, J. F.	Dam Collapse on a Stream Fish Community.	teria in Biofilms.
Use of Ligand-Modified Micellar-Enhanced Ul-	W91-11558 2E	W91-10642 5B
trafiltration in the Selective Removal of Metal Ions from Water.	SCHMELZ, P. Bdellovibrio sp.: A Predator under Groundwat-	SCHUMANN, T.
W91-11318 5D	er Conditions. A Short Communication.	Aerosol and Hydrometeor Concentrations and
SCAVIA, D.	W91-10676 5B	Their Chemical Composition During Winter Precipitation Along a Mountain Slope: III. Size-
Size Structure of Particulate Biogenic Silica in	SCHMIDT, N.	Differentiated In-Cloud Scavenging Efficiencies.
Lake Michigan.	Residential Water Conservation: Casa Del Agua.	W91-11253 2B
W91-10975 2H	W91-10814 3D	SCHUUR, T. J.
SCHAD, T. M.	SCHNEIDER, S.  Species and Genera of Enterobacteriaceae in	Electrical and Kinematic Structure of the Strati- form Precipitation Region Trailing an Oklahoma
Do We Have a National Water Policy. W91-10505 6B	River Neckar and After River Bank Filtration	Squall Line.
	and Their Resistance Patterns to Antibiotics and	W91-10514 2B
Past, Present, and Future of Water Resources Management In the United States.	Heavy Metal Salts. W91-10675 5B	SCHUURMANN, G.
W91-11207 4A		Acute Aquatic Toxicity of Alkyl Phenol Ethox-
SCHAEFER, C. H.	SCHNESE, W. Rotifers of the Genus SynchaetaAn Important	ylates. W91-10833 5C
Studies on the Environmental Persistence of S-	Component of the Zooplankton in the Coastal	
31183 (Pyriproxyfen): Adsorption onto Organic Matter and Potential for Leaching through Soil.	Waters of the Southern Baltic. W91-11519 2L	SCHWARTZBROD, J. Wastewater and Giardia Cysts.
W91-10831 5B		W91-10648 5B
SCHAEFFER-NOVELLI, Y.	SCHNOOR, S. L. Kinetics of Chemical Weathering in B Horizon	SCHWARTZBROD, L.
Oil Spills in Mangroves: A Conceptual Model	Spodosol Fraction.	Comparison of Two Methods for the Recovery
Based on Long-term Field Observations. W91-10489 5B	W91-11233 5C	of Rotavirus from Mussels and Oysters. W91-10697 5A
	SCHOENBERG, M. E.	
SCHEBEK, L.  Methyl and Butyltin Compounds in Water and	Monthly Mean Discharge at and Between Se- lected Streamflow-Gaging Stations Along the	Detoxification by Sephadex LH20 of Seafood Concentrates for Rotavirus Assay.
Sediments of the Rhine River.	Mississippi, Minnesota, and St. Croix Rivers,	W91-10696 5A
W91-11335 5B	1932-87.	Recovery of Enterovirus from Primary Sludge
SCHEFFLER, W.	W91-10760 2E	Using Three Elution Concentration Procedures.
Diatom Analysis, Late-Glacial and Post-Glacial	SCHOLZ, H. M.	W91-10657 5A
Development of Lake Kleiner Barsch-See (GDR)A Preliminary Note.	Development of an Enzyme Immunoassay for the Determination of Metazachlor.	SCHWEISFURTH, R.
W91-11517 2H	W91-11295 5A	Species and Genera of Enterobacteriaceae in
SCHENKEL, W.	SCHONBORN, W.	River Neckar and After River Bank Filtration and Their Resistance Patterns to Antibiotics and
Modern Sludge Management: The Manager's	Analysis of Subfossil Shelled Protozoa in the	Heavy Metal Salts.
Choice. W91-11122 5D	Sediments of a Small Acid Forest Lake (Kleiner Barsch-See, Northern GDR) (Analyse Subfos-	W91-10675 5B
	siler Protozoenschalen der Sedimente eines	SCOTT, A. G.
SCHERTZ, T. L. Trends in Water-Ouality Data in Texas.	Kleinen Sauren Waldsees) (Kleiner Barsch-See, Nordliche DDR).	Effects of Changes in Land Use on Annual Streamflows in the Lake Huron Basin of Canada
W91-11593 5B	W91-11516 2H	
SCHEUERMAN, P. R.	SCHONWIESE, C. D.	W91-11021 4C
Laboratory Studies of Virus Survival During	Some Updated Statistical Assessments of the	SCOTT, R. W.
Aerobic and Anaerobic Digestion of Sewage	Surface Temperature Response to Increased	
Sludge. W91-11319 5D	Greenhouse Gases. W91-10969 2B	Spring Caused by St Louis. W91-10500 2B
		40

SEBETICH, M. J.	SHAMBERGER, H. A.	SHULTZ, D. J.
Primary Productivity and Plankton Communi- ties in a Two-Reservoir Series. W91-10815 2H	Evolution of Nevada's Water Laws, as Related to the Development and Evaluation of the State's Water Resources, from 1866 to about	Transport and Fate of Acetone in an Outdoor Model Stream, Stennis Space Center near Bay St. Louis, Mississippi.
CEIDEL P. M.	1960.	W91-11103 5B
SEIDEL, K. M. Disinfection Capability in Water for Swimming	W91-11573 6E	
and Bathing Pools: A Simple Method for Their	SHANKS, D. E.	SHUTER, B. J.
Evaluation in Practice.	Removal of Heavy Metals and Other Cations	Chemical and Biological Factors Affecting Acid Tolerance of Smallmouth Bass.
W91-10684 5F	From Wastewater Using Zeolites.	W91-11530 5C
SEIDERER, L. J.	W91-11369 5D	
Modification of Benthic Community Structure	SHAPIRO, H. A.	SHUVAL, H.
in Response to Acid-Iron Wastes Discharge.	Toward Environmental Planning for East Asian	Control of Enteric Micro-organisms by Aerobic- Thermophilic Co-Composting of Wastewater
W91-10869 5C	Estuaries: Japanese and Chinese Enclosed Bays.	Sludge and Agro-Industry Sludge.
SEIDL, P.	W91-10565 2L	W91-10693 5E
Successes and Challenges in Developing and Implementing Remedial Action Plans to Restore	SHARMA, P.	CINT IIV II V
Degraded Areas of the Great Lakes.	Comparative Physico-Chemical Analysis of	SIBLEY, P. K. Impact of a Pulse Application of Permethrin on
W91-11030 6A	Drinking, Ground and Industrial Waste Water	the Macroinvertebrate Community of a Head-
SEIKI, T.	of Jodhpur. W91-11083 5B	water Stream.
Eutrophication in Hiroshima Bay.		W91-11456 5C
W91-Î0536 5B	Estimation of Trace Metals Levels in Power and	SIEGEL, D. I.
SEKINE, M.	Industrial Waste Water of Jodhpur by Differen- tial Pulse Anodic Stripping Voltammetry.	Evidence for Dilution of Deep, Confined
Evaluation of Primary Production Loads and	W91-11084 5A	Ground Water by Vertical Recharge of Isotopi-
Their Control in Enclosed Seas.		cally Heavy Pleistocene Water.
W91-10524 5G	SHARPE, H. E. Brine-Induced Advection of Dissolved Aromat-	W91-10792 2F
SEMMENS, M. J.	ic Hydrocarbons to Arctic Bottom Waters.	Fate of Silicate Minerals in a Peat Bog.
Bubbleless Aeration. W91-11222 5G	W91-11340 5B	W91-10789 2H
W91-11222 5G	CHANDY M P	Groundwater Flow and the Metal Content of
SEMPRINI, L.	SHAWKY, M. E. Effect of Low Salinity Water on Salt Displace-	Pest.
Comparison Between Model Simulations and Field Results for In-Situ Biorestoration of Chlor-	ment in Two Soils.	W91-10902 2F
inated Aliphatics: Part 1. Biostimulation of	W91-11433 2G	
Methanotrophic Bacteria.	SHEALY, R. T.	Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial
W91-10955 5G	Precipitation Changes in Fall, Winter, and	Evaluation.
SENIOR, W.	Spring Caused by St Louis.	W91-11062 5B
Studies of Dissolved Carbohydrates (or Carbo-	W91-10500 2B	SIEGRIST, H.
hydrate-Like Substances) in an Estuarine Envi-	SHELTON, T. B.	Pathway Analysis of Selected Organic Chemi-
ronment. W91-10840 2L	Buffer Strips to Protect Water Supply Reser-	cals from Sewage to Agricultural Soil.
	voirs: A Model and Recommendations.	W91-11123 5B
SERIGSTAD, B. Immunochemical Detection of Cytochrome	W91-10816 5G	SIEKMANN, K.
P450IA1 Induction in Cod Larvae and Juveniles	SHERWOOD, D. R.	Aerobic-Thermophilic Methods for Disinfecting
Exposed to a Water Soluble Fraction of North	Status Report on Remedial Investigation of the	and Stabilizing Sludge.
Sea Crude Oil.	300 Area Process Ponds. W91-11583 5G	W91-11143 5D
W91-10871 5A		SIEMIATYCKI, J.
SERRAZANETTI, G. P.	SHIATI, K.	Prospective Epidemiological Study of Drinking
Seasonal Variations of Aliphatic Hydrocarbons in Sardina pilchardus (Walb.) (Teleostei: Clupei-	Regional Approach to Salinity Management in River Basins. A Case Study in Southern Iran.	Water Related Gastrointestinal Illnesses. W91-10618 5B
dae) Tissues.	W91-11432 5G	W91-10618 5B
W91-10839 5B	CHITTEN M. C.	SIENKOWSKA-ZYSKOWSKA, E.
SEVILLANO, M. A.	SHIEH, M. C. Study on Triple-Membrane-Separator (TMS)	Continuous Flow Thin-Layer Headspace
Morphology and Quantitative Analysis of Fluvi-	Process to Treat Aqueous Effluents Containing	(TLHS) Analysis. I. Conductometric Determi- nation of Volatile Organic Halogens (VOX) is
al Erosion Systems in the Hydrological Network	Uranium.	Tap Water.
of the Basque Country Autonomous Region. W91-11265	W91-11367 5D	W91-11256 5A
	SHIEH, W. K.	SIERRA-ALVEREZ, R.
SEWELL, G. W.	Oxic Fluidized-Bed Treatment of Dichlorophen-	Anaerobic Biodegradability and Methanogenic
Stimulation of the Reductive Dechlorination of Tetrachloroethene in Anaerobic Aquifer Micro-	ols. W91-11485 5D	Toxicity of Dulning Wastewaters
cosms by the Addition of Toluene.	W91-11485 5D	W91-11480 5E
W91-11344 5B	SHIELDS, M. T.	Future Perspectives for the Anaerobic Treat
SEYFRIED, M. S.	Dynamical Forcing and Mesoscale Organization	ment of Forest Industry Wastewaters.
Spatial and Temporal Influence of Soil Frost on	of Precipitation Bands in a Midwest Winter Cy- clonic Storm.	W91-11478 5D
Infiltration and Erosion of Sagebrush Range-	W91-11424 2B	SILL B. L.
lands. W91-10820 2G		Evaporative Drying of Dredged Material.
	SHIOZAWA, T.  Heavy Metal Pollution in Sediment from the	W101 11000
SHABMAN, L. Limits of Government Responsibility	Seto Inland Sea, Japan.	
Limits of Government Responsibility. W91-11034 6E	THE LOCAL STREET	SIM, L. K. Urbanization and Urban Water Problems is
	SHISHCHENKO, P. G.	Southeast Asia: A Case of Unsustainable Devel
So What. Findings and Recommendations from the Lake Levels Study.	Secondary Salinization of Soils of the Dniester	opment.
W91-11037 6A	Delta Floodplain.	W91-11263 60
	W91-10917 2G	SIMANTON, J. R.
SHAH, R. M.  Dioxin Contamination and Growth and Devel-	SHOOTS, W.	WEPP: Soil Erodibility Experiments for Range
opment in Great Blue Heron Embryos.	Limits of Government Responsibility.	land and Cropland Soils.
ŵ91-10837 5C	W91-11034 6E	W91-10512 2

SIMMONS, D. L. Use of Ligand-Modified Micellar-Enhanced Ultrafiltration in the Selective Removal of Metal Ions from Water.	SIVARAMAKRISHNA, B. Assessment of Mercury Toxicity by the Changes in Oxygen Consumption and Ion Levels in the Freshwater Snail, Pila globosa, and the Mussel,	SMITH, K. A.  Effect of Pesticide Treatments on Nontarget Organisms in California Rice Paddies.  W91-10835 5C
W91-11318 5D	Lamellidens marginalis.	
SIMONOV, A. D.	W91-11304 5C	SMITH, L. G.
Thermocatalytic and Chemical Treatment of	SLABBERT, J. L.	Changing Dynamics of Interest Representation in Water Resources Management.
Lignin-Aluminium Sludge and Utilization of the	Microbiological Methods for Safety Testing of	W91-11007 6E
Resulting Adsorbent-Coagulant.	Drinking Water Directly Reclaimed from	W91-1100/
W91-11503 5D	Wastewater.	SMITH, M. A. K.
SIMONOVIC, S. P.	W91-10613 5A	Models of Seasonal Growth of the Equatorial
Knowledge-Based Systems and Operational Hy-	SLADE, J.	Carp Labeo dussumieri in Response to the River
drology.	Isolation and Identification of Cryptosporidium	Flood Cycle.
W91-11273 7C	from Water.	W91-11559 2H
Risk-based Performance Criteria for Real-time	W91-10644 5A	SMITH, M. G.
Reservoir Operation.	SLATER, D.	Water Market in the Southern Front Range of
W91-11275 4A	Activity of Peracetic Acid on Sewage Indicator	Colorado.
SIMPSON, C. J.	Bacteria and Viruses.	W91-11055 6D
NOAA Satellite Data in Natural Oil Slick De-	W91-10683 5D	
tection, Otway Basin, Southern Australia.	SLAUENWHITE, D. E.	SMITH, N.
W91-11296 5A	Effect of a Spring Phytoplankton Bloom on	Effects of Acid Rain on Epiphytic Orchid
SIMPSON, H. J.	Dissolved Copper Speciation in Bedford Basin.	Growth.
Major Incident of Dioxin Contamination: Sedi-	W91-10543 5B	W91-11076 5C
ments of New Jersey Estuaries.	STOOPE W	SMITH, P. G.
W91-11341 5B	SLOOFF, W.  Ecotoxicological Effects Assessment: A Com-	Occurrence and Viability of Giardia spp. Cysts
Salinity and Evaporation in the River Murray	parison of Several Extrapolation Procedures.	in UK Waters.
Basin, Australia.	W91-10830 5A	W91-10647 5B
W91-10989 2E	CASED IIII DAGADA D	
	SMED-HILDMANN, R.	SMOLLEY, M.
SINERIZ, F.	Bdellovibrio sp.: A Predator under Groundwat- er Conditions. A Short Communication.	Cone Penetrometer Tests and HydroPunch
Denitrification by Thermophilic Soil Bacteria With Ethanol as Substrate in a USB Reactor.	W91-10676 5B	Sampling: A Screening Technique for Plume
With Ethanol as Substrate in a USB Reactor. W91-11254 5D	W >1-100/0	Definition.
	SMIT, B.	W91-10794 5A
SINGH, A. K.	Fluctuating Water Levels: An Issue Manage-	SMULL, B. F.
Inhibition of NO3(-), NH4(+), and PO4(3-)	ment Approach. W91-11033 6B	Electrical and Kinematic Structure of the Strati-
Uptake in Anabaena doliolum Exposed to a Pe- troleum Oil.	W91-11033	form Precipitation Region Trailing an Oklahoma
W91-10825 5C	So What. Findings and Recommendations from	Squall Line.
	the Lake Levels Study.	W91-10514 2B
SINGH, J.	W91-11037 6A	COURT IN
Ultrastructural and Biochemical Effects of Cad- mium on the Aquatic Fern Marsilea minuta	SMITH, A. E.	SMYLE, J. W.
Linn.	Transformation of (C-14)-2,4-Dichlorophenol in	Soil and Moisture Conservation Technologies: Review of Literature.
W91-10829 5C	Saskatchewan Soils.	W91-11565 4D
	W91-10922 5B	W91-11303
SINGH, K. P.	SMITH, D. A.	SNELL, T. W.
Unit Hydrographs for Developing Design Flood Hydrographs.	Rural Clean Water Program.	Effects of Copper and Tributyltin on Stress Pro-
W91-10809 2E	W91-11184 5G	tein Abundance in the Rotifer Brachionus plica-
		tilis.
SINGH, M.	SMITH, D. E.  Application of Physicochemical Treatment to an	W91-10900 5C
Biodegradation of Benzene and a BTX Mixture Using Immobilized Activated Sludge.	Overloaded Sewage Works.	SOARES, M. I. M.
W91-11381 5D	W91-11357 5D	Denitrification in Laboratory Sand Columns:
		Carbon Regime, Gas Accumulation and Hy-
SINGH, N. C.	SMITH, G. S.	draulic Properties.
Dynamics of Pesticides in Tropical Conditions.  1. Kinetic Studies of Volatilization, Hydrolysis,	Brine-Induced Advection of Dissolved Aromat-	W91-11330 5G
and Photolysis of Dieldrin and Alpha and Beta	ic Hydrocarbons to Arctic Bottom Waters. W91-11340 5B	
Endosulfan.	30	SOBSEY, M. D.
W91-11375 5B	SMITH, H. V.	Comparative Inactivation of Hepatitis A Virus
	Occurrence and Viability of Giardia spp. Cysts	and Other Enteroviruses in Water by Iodine.
SINGHAL, S. Seasonal Variations and Relationships of Differ-	in UK Waters.	W91-10679 5F
ent Physico-chemical Characteristics in Newly	W91-10647 5B	SOEDA, T.
Made Tawa Reservoir.	Occurrence of Cryptosporidium spp. Oocysts in	Environmental Information Processing of
W91-11528 2H	Scottish Waters, and the Development of a	Closed Bay Area by Remote Sensing.
	Fluorogenic Viability Assay for Individual	W91-10581 - 7B
SIRENKO, L. A.	Cryptosporidium Oocysts.	
Effect of Hydroelectric Stations on Water Qual- ity and Development of Phytoplankton in the	W91-10645 5B	SOEDER, C. J.
Lower Pools of Reservoirs.	SMITH, J.	1-Naphthalenesulfonic acid and Sulfate as Sulfur
W91-11289 6G	Evaluating Aeration Technology for Radon Re-	Sources for the Green Alga Scenedesmus obli- quus.
	moval.	quus. W91-11326 5D
SIROIS, A.	W91-11462 5F	W 21-11-320 3D
Relationship Between Mean and Standard Devi- ation in Precipitation Chemistry Measurements	SMITH I A	SOENKSEN, P. J.
Across Eastern North America.	SMITH, J. A.  Estimation of the Mean Field Bias of Radar	Automatic Tracer-Dilution Method Used for
W91-10475 2B	Rainfall Estimates.	Stage-Discharge Ratings and Streamflow Hy-
	W91-10857 2B	drographs on Small Iowa Streams.
SISSON, J. B.		W91-11111 7B
Improved Analysis of Gravity Drainage Experi-	SMITH, J. B.	SOJO, L. E.
ments for Estimating Unsaturated Soil Hydraulic Functions.	Potential Impacts of Climate Change on the Great Lakes.	Multicomponent Kinetic Analysis of Iron Speci-
W91-11237 2G	W91-10480 2H	ation in Humic Lake Tjeukemeer: Comparison
		- Junean Companison

of Fulvic Acid from the Drainage Basin and Lake Water Samples. W91-11339 2H	Technical Requirements and Possibilities of Incineration. W91-11129 5D	Transport and Fate of Acetone in an Outdoor Model Stream, Stennis Space Center near Bay St. Louis, Mississippi.
SOLBERG, T. S.	SPRAGUE, J. B.	W91-11103 5B
Immunochemical Detection of Cytochrome P450IA1 Induction in Cod Larvae and Juveniles Exposed to a Water Soluble Fraction of North	Environmentally Desirable Approaches for Reg- ulating Effluents from Pulp Mills.	STEPHENS, L. Oregon Pesticide Container Initiative.
Sea Crude Oil.	W91-11504 5G	W91-11192 5E
W91-10871 5A	SPRINGER, A. E. Delineation of Traveltime-Related Capture	STEPHENS, R. D.
SOLDA, P. Microbial Biomass and Biological Activities in an Acid Sandy Soil Treated with Sewage Sludge or Farmyard Manure in a Long Term Field Experiment.	Areas of Wells Using Analytical Flow Models and Particle-Tracking Analysis. W91-10957 2F	Determination of Chlorinated Phenoxy Acid and Ester Herbicides in Soil and Water by Liquid Chromatography Particle Beam Mass Spectrometry and Ultraviolet Absorption Spec- trophotometry.
W91-11160 5E	Natural Phosphate Source for Lake Waccamaw,	W91-10893 5A
SONNLEITNER, B. Thermophilic Aerobic Stabilisation.	North Carolina, USA. W91-11405 2H	STERN, C. Determination of Nitroaromatics and Nitramines
W91-11134 5D	STAHL, R.	in Ground and Drinking Water by Wide-Bore
SONOKI, S. Clostridium perfringens, as an Indicator Micro-	Wetland Impoundments of East-Central Florida. W91-10854 2L	Capillary Gas Chromatography. W91-11262 5A
organism for the Evaluation of the Effect of	STAHLE, D. W.	
Wastewater and Sludge Treatment Systems. W91-10686 5D	Tree-Ring Reconstructed Sunshine Duration over Central USA.	STEWART, C. J. Fluctuating Water Levels: An Issue Manage-
SORBER, C. A.	W91-10972 2I	ment Approach. W91-11033 6B
Determining Giardiasis Prevalence by Examina-	STAMEY, T. C.	#71-11033 6B
tion of Sewage. W91-10646 5A	Update of Flood-Flow Characteristics of Nancy Creek at Georgia Highway 400 Extension Near	STEWART, R. E. Canadian Atlantic Storms Program: Progress
Distribution of Giardia Cysts in Wastewater. W91-10649 5B	Atlanta, Georgia. W91-10762 2E	and Plans of the Meteorological Component. W91-10943 2B
SOULIOS, G. Contribution to the Study of the Recession	STANIA, K. Health Risk Assessment of Water Contaminants	STINE, S. Geomorphic, Geographic, and Hydrographic
Curves of Karstic Springs: Examples from Greece (Contribution a l'Etude des Courses de	Using Baseline Data of Cancer Incidence in Dif- ferent Water Supply Areas.	Basis for Resolving the Mono Lake Controver- sy.
Recession des Sources Karstiques: Exemples du Pays Hellenique).	W91-10614 5F	W91-11442 6G
W91-10990 2F	STANSBURY, J.  Decision Support System for Water Transfer	STITES, W.  Method for Installing Miniature Multilevel Sam-
SOUTHAM, C. Great Lakes Levels and Flows Under Natural and Current Conditions.	Evaluation. W91-11226 6A	pling Wells. W91-10962 5A
W91-11022 2H	STANWELL-SMITH, R.	STOCK, J. D.
SOWELL, M. L. Maryland's Train-The-Trainer Program House- hold Hazardous Waste.	Results of the First Pilot-Scale Controlled Cohort Epidemiological Investigation into the Possible Health Effects of Bathing in Seawater at Langland Bay, Swansea.	Short-Term Effects of a Catastrophic Beaver Dam Collapse on a Stream Fish Community. W91-11558 2E
W91-11200 5G	W91-11366 5C	STOHR, M.
SPACIE, A. Acute Phototoxicity of Harbor and Tributary Sediments from Lower Lake Michigan. W91-10977 5C	STEADMAN, B. Sensitivity of Greenback Cutthroat Trout to Acidic pH and Elevated Aluminum.	Usefulness of Various Numerical Methods for Assessing the Specific Effects of Pollution on Aquatic Biota. W91-11406 5C
SPAGGIARRI, G.	W91-11531 5C	
Control of Enteric Micro-organisms by Aerobic- Thermophilic Co-Composting of Wastewater Sludge and Agro-Industry Sludge. W91-10693 5E	STEIN, R.  Organic Carbon Accumulation in Baffin Bay and Paleoenvironment in High Northern Latitudes During the Past 20 m. y.	STOLL, U.  Stabilization of Sewage Sludge and Its Disinfection According to Specific Requirements: Two- Stage Anaerobic/Aerobic Operating Tech-
SPALDING, C. P.	W91-10791 2J	niques.
Evaluation of Analytical Solutions to Estimate Drawdowns and Stream Depletions by Wells.	STEINHORN, I. Concept of Evaporation from Fresh and Saline	W91-11141 5D STONE, L.
W91-11240 2F	Water Bodies. W91-11244 2D	Distribution of Fecal Pollution Indicator Bacteria in Lake Kinneret.
SPECHT, W. L. Comprehensive Cooling Water Study, Final	STELZER, W.	W91-11322 5B
Report. Volume I: Summary of Environmental Effects.	Study of Campylobacter in Sewage, Sewage Sludge and in River Water.	STOSSMEISTER, G. J.
W91-10729 5B	W91-10634 5D	Convective Cell in a Hurricane Rainband. W91-11422 2B
SPIERING, W. Treatment of Waste Water From Wet	STENBY, E. W. Environmental Control Impacts of Selected Al-	STOTT, R. F.
Lime(Stone) Flue Gas Desulfurization Plants With Aid of Crossflow Microfiltration.	ternate Fuels on Existing Power Plants. W91-11078 5G	Sewage Treatment with Plants. W91-11466 5D
W91-11371 5D		STRAIT, J. R.
SPIGONI, C. Control of Enteric Micro-organisms by Aerobic- Thermophilic Co-Composting of Wastewater	STEPHENS, D.  Hydrologic Characteristics of the Great Salt Lake, Utah: 1847-1986.	Sensitive High-Performance Liquid Chromato- graphic Analysis for Toxicological Studies with
Sludge and Agro-Industry Sludge. W91-10693 5E	W91-11597 2H	W91-10920 5A
SPINOSA, L.	STEPHENS, D. W. Fate of Acetone in an Outdoor Model Stream	STRAPPE, P.
Influence of Polyelectrolyte Characteristics on	with a Nitrate Supplement, Southern Mississippi, U.S.A.	Rotavirus Detection: A Problem that Needs Concentration.
Sludge Conditioning (Lab Evaluations). W91-10701 5D	W91-10903 5B	

STRASSLER, E.	SUTCLIFFE, E. M.	TAKARADA, M.
Preliminary Data Summary for the Hospitals Point Source Category.	Latex Agglutination for the Detection of Cam- pylobacter Species in Water.	Flow Control Technology for Enhancement and Diverse Use of the Marine Environment.
W91-10738 5B	W91-11465 5A	W91-10607 2L
STRAUB, U.	SUVAPEPUN, S.	TARENGOTO A
Behaviour of Pathogenic Bacteria, Phages and	Long Term Ecological Changes in the Gulf of	TAKEMOTO, A.  Computer Visualization System for Sediment
Viruses in Groundwater During Transport and Adsorption.	Thailand. W91-10551 5B	Pollution in Japan.
W91-10672 5B		W91-10609 7C
STRAUCH, D.	SUZUKI, H.  Meteorology and Oceanography in the Seto	TAKEOKA, H.
Improvement of the Quality of Sewage Sludge:	Inland Sea.	Water Exchange and Transport of Matter in the
Microbiological Aspects.	W91-10520 2L	Seto Inland Sea.
W91-11125 5D	SWART, P. J. F.	W91-10527 2L
STRENGE, D. L.	Microwave Transmission, a New Tool in Forest	TAKEUCHI, R.
Estimation of Sport Fish Harvest for Risk and Hazard Assessment of Environmental Contami-	Hydrological Research.	Recovery of Aquatic Animals in Dokai Bay,
nants.	W91-10995 2I	Northern Kyushu, Japan.
W91-11556 5G	SWINTON, E. A.	W91-10550 5G
STUDER, F.	Extraction of Heavy Metals from Sludges and Muds by Magnetic Ion-Exchange.	TAKI, K.
Experience with Low-Head HydroPlant Fre-	W91-11145 5D	Computer Visualization System for Sediment
quency Control. W91-11214 8C	SYKORA, J. L.	Pollution in Japan.
	Determining Giardiasis Prevalence by Examina-	W91-10609 7C
STURARO, A. Use of 2,2-Dimethoxypropane for the Direct	tion of Sewage.	TAKITA, C. S.
Gas Chromatographic-Mass Spectrometric De-	W91-10646 5A	Assessment of Agricultural Nutrient Point
termination of Some Organic Compounds in	Distribution of Giardia Cysts in Wastewater.	Source Discharge from Tile Drains, Spring and
Water. W91-11245 5A	W91-10649 5B	Overland Runoff from Two Farms, Dauphin County, Pennsylvania.
	SYMONS, I. F.	W91-11600 5B
STUTHRIDGE, T. R. Treatability of Bleached Kraft Pulp and Paper	Pressure of Clay Backfill against Retaining	
Mill Wastewaters In a New Zealand Aerated	Structures. W91-10947 8D	TALBOT, P.
Lagoon Treatment System. W91-11499 5D		Comparative Study and Mathematical Modeling of Temperature, Light and Growth of Three
	SZINOVATZ, W.  Treatment of Pulp-Bleaching Effluents by Acti-	Microalgae Potentially Useful for Wastewater
STYLIANOU, Y.  Trickle Irrigation of Sunflower With Municipal	vated Sludge, Precipitation, Ozonation and Irra-	Treatment.
Wastewater.	diation.	W91-10937 5D
W91-11435 3F	W91-11491 5D	TALMAGE, S. S.
SUBRAMANIAN, V.	TADDESE, A.	Treatability of Hazardous Chemicals in Soils:
Heavy Metal Distribution in the Godvari River	FACTA 1990 Conservation and Environmental Highlights.	Volatile and Semivolatile Organics. W91-10712 5B
Basin. W91-11445 5B	W91-10507 5G	W31-10/12
	TAFF, S. J.	TAMBO, N.
Nature of Suspended Solids and IRS1A-LISSI Data: A Case Study of Tawa Reservoir (Nar-	Micro-Targeting Cropland Retirement for	Criteria for Flocculator Design. W91-11269 5F
mada Basin).	Water Quality Improvement: Measuring the	W91-11209 3F
W91-11221 5G	Benefits of Increased Information. W91-11052 3F	TANABE, H.
SUDICKY, E. A.		Flow Control Technology for Enhancement and Diverse Use of the Marine Environment.
Geostatistical Characteristics of the Borden Aq- uifer.	TAFFET, M. Soil Vapor Survey at the LLNL Site 300 Gener-	W91-10607 2L
W91-11234 2F	al Services Area, Adjacent Portions of the Con-	
SUETA, S.	nolly and Gallo Ranches and the Site 300 Land-	TANAKA, F.
Recovery of Aquatic Animals in Dokai Bay,	fill Pit 6 Area. W91-10747 5B	Analysis of Precipitation Chemistry Measure- ments in Shimane, Japan.
Northern Kyushu, Japan.		W91-10472 2B
W91-10550 5G	TAHERUZZAMAN, Q. Influence of Leaf Leachate-Enriched Water of	MANAGE A
SUGAWARA, M.	Neem (Azadirachta indica A. Juss.) and Shirish	TANAKA, K.  Eutrophication Mechanisms of Coastal Seas in
Runoff Analysis of the Chang Jiang (The Yangtze River).	(Albizzia lebbek Benth.) on the Growth of Eich-	Yamaguchi Prefecture.
W91-10966 2E	hornia crassipes (Mart.) Solms. W91-11449 2I	W91-10593 5B
SUNDA, W. G.		TANAKA, M.
Trace Metal Interactions with Marine Phyto-	TAI, D. Y.	Benthic Faunal Succession in a Cove Organical-
plankton.	Fate of Acetone in an Outdoor Model Stream with a Nitrate Supplement, Southern Mississippi,	ly Polluted by Fish Farming.
W91-10853 2L	U.S.A.	W91-10554 5C
SUNDELIN, B.	W91-10903 5B	TANIMOTO, T.
Meiofauna of an Experimental Soft Bottom Eco- systemEffects of Macrofauna and Cadmium	Transport and Fate of Acetone in an Outdoor	Heavy Metal Pollution in Sediment from the
Exposure.	Model Stream, Stennis Space Center near Bay	Seto Inland Sea, Japan.
W91-10519 5C	St. Louis, Mississippi. W91-11103 5B	W91-10537 5B
SURESH, A.		TAO, P. C.
Assessment of Mercury Toxicity by the Changes	TAKAHASHI, B.  Vapor Diffusional Growth of Free-Falling	Managing Transboundary Water Diversions:
in Oxygen Consumption and Ion Levels in the Freshwater Snail, Pila globosa, and the Mussel,	Snow Crystals Between -3 and -23 C.	Experience From a Private Utility.
Lamellidens marginalis.	W91-10515 2C	W91-11045 6A
W91-11304 5C	TAKAHASHI, S.	TAPHORN, D. C.
SUSS, A.	Embedding and Response Matrix Techniques for	Drift of the Characin Larvae, Bryconamericus
Studies for a Simultaneous Use of Liquid Manure and Sewage Sludge.	Maximizing Steady-State Ground-Water Extrac- tion; Computational Comparison.	deuterodonoides, During the Dry Season from Andean Piedmont Streams.
W91-11157 5E	W91-10954 2F	W91-11560 2H

2H

TARAZONA, F.	Transport of Microorganisms in the Under-	Treatment of Waste Water From Wet
Chemical Properties of Sewage Sludges Produced in the Valencian Area (Spain). W91-11159 5A	ground: Processes, Experiments and Simulation Models. W91-10674 5B	Lime(Stone) Flue Gas Desulfurization Plants With Aid of Crossflow Microfiltration. W91-11371 5D
TASKER, G. D.	THE ALL T I A	
Techniques for Estimation of Storm-Runoff Loads, Volumes, and Selected Constituent Con-	THEBAULT, J. M. Comparative Study and Mathematical Modeling of Temperature, Light and Growth of Three	TILLETT, H. E. Preliminary Statistical Assessment of UK Water Quality Control Trials.
centrations in Urban Watersheds in the United States. W91-11094 5B	Microalgae Potentially Useful for Wastewater Treatment.	W91-10624 5G
W91-11094 5B	W91-10937 5D	TIPPING, E.
TATANO, T.  Analysis of Precipitation Chemistry Measure-	THOMAS, C. Application of Physicochemical Treatment to an	Humic Substances in Acid Surface Waters; Modelling Aluminium Binding, Contribution to Ionic Charge-Balance, and Control of pH.
ments in Shimane, Japan. W91-10472 2B	Overloaded Sewage Works. W91-11357 5D	W91-10933 5C
TATE, D.	THOMAS, J. M.	TISCHLER, J.
Industrial Water Pricing for Ontario: Towards Realistic Pricing. W91-11048 6C	Geochemical Evolution of Ground Water in Smith Creek Valley-A Hydrologically Closed	Long Climb to Remediation. W91-10483 5G
W31-11046 0C	Basin in Central Nevada, U.S.A.	TIWARI, S. K.
TAUCHER, J. A.	W91-11392 2K	Spectrophotometric Determination of Nitrite in
Identification of Dioxin Sources In an Integrated Wood Processing Facility.	THOMAS, R.	Polluted Waters Using 3-Nitroaniline.
W91-11475 5B	Heavy Metal Transport to the Great Lakes by Natural Ground-Water Discharge: An Initial	W91-10823 5A TJERNSTROM, M.
TAYLOR, C. H.	Evaluation.	Estimating the Effects on the Regional Precipi-
Streamflow Generation in a Headwater Basin on the Precambrian Shield.	W91-11062 5B	tation Climate in a Semiarid Region Caused by
W91-11349 2E	THOMPSON, M. Watershed-Based Conservation Programs is the	an Artificial Lake Using a Mesoscale Model. W91-10502 2B
TAYLOR, C. M. Upstream Extirpation of Four Minnow Species	Public Getting Its Money's Worth. W91-11044 6C	TOBSCHALL, H. J.
Due to Damming of a Prairie Stream.	W91-11044	Methyl and Butyltin Compounds in Water and
W91-11535 6G	THOMPSON, R. L. Farmer-Initiated Project to Promote Sustainable	Sediments of the Rhine River.
TAYLOR, J. G.	Agriculture in Cooperation with the Extension	W91-11335 5B
Negotiation Techniques to Resolve Western	Service.	TODD, D. E.
Water Disputes. W91-10817 6E	W91-11203 3F	Hydrogeochemical Processes Controlling Sub-
	THOMPSON, T. R. E.	surface Transport from an Upper Subcatchment
TAYLOR, K. E. Observational and Theoretical Studies of Green-	New Developments in Sampling Sludge Treated	of Walker Branch Watershed During Storm Events. 2. Solute Transport Processes.
house Climate Effects.	Soils.	W91-10908 5B
W91-11067 5C	W91-11158 5A	11.00
TAYLOR, R. W.	THONING, K. W.	TODD TRENCH, E. C.
Use of Ligand-Modified Micellar-Enhanced Ul- trafiltration in the Selective Removal of Metal	Relation of Atmospheric CO2 to Tropical Sea and Air Temperatures and Precipitation.	Hydrogeology, Water Quality, and Ground- Water Development Alternatives in the Lower Wood River Ground-Water Reservoir, Rhode
Ions from Water.	W91-11002 2B	Island.
W91-11318 5D	THORBURN, P. J.	W91-11572 2F
TAYLOR, S. J.	Effect of Land Development on Groundwater	TODORCHICE I D
Critical Area Program of Maryland: Is it Clean-	Recharge Determined from Non-Steady Chlo-	TODOESCHUCK, J. P. Analysis of Ground-Probing Radar Data: Pre-
ing Up the Chesapeake Bay.	ride Profiles. W91-10991 4C	dictive Deconvolution.
W91-11006 6B		W91-10782 8G
TEDESCHI, S.	THORN, C. R. Hydrogeology of the Point Lookout Sandstone	TOMASZEWSKI, J.
Assessment of the Environmental Capacity of Enclosed Coastal Sea.	in the San Juan Structural Basin, New Mexico,	Studies of Springs in the Southern Part of the
W91-10571 5E	Colorado, Arizona, and Utah.	Valley of Mexico (Estudio Crenologico en la
TEKLEHAIMANOT, Z.	W91-11114 2F	Parte Meridional de la Cuenca de Mexico). W91-11352 2E
Rainfall Interception and Boundary Layer Con-	THORNBURN, G.	
ductance in Relation to Tree Spacing.	Applying Sustainable Development to the Great	TONG, H.
W91-10905 2I	LakesExperience and Opportunities Under the Boundary Waters Treaty.	Major Incident of Dioxin Contamination: Sedi- ments of New Jersey Estuaries.
TEN HAVE, P. J. W.	W91-11019 6E	W91-11341 5I
Dutch Approach to Manure Processing. W91-10703 5D	THORNWALL, G. C.	
	Sensitive High-Performance Liquid Chromato-	TORII, K.  Eutrophication Mechanisms of Coastal Seas in
TEN WOLDE, J. G. Processing Organic Waste Products to Black	graphic Analysis for Toxicological Studies with	Yamaguchi Prefecture.
Soil and Organic Fertilizers.	Carbaryl. W91-10920 5A	W91-10593 5I
W91-10705 5E	W91-10920 5A	TORRES, G.
TERRILL, T. H.	THURMAN, E. M.	Emerging Issues at the Intersection of Agricul
Influence of Flooded Soil on Chemical Compo- sition of Annual Ryegrass and Digestibility by	Planned Studies of Agrichemicals in Ground and Surface Water in the Mid-Continental	tural and Environmental Policy. W91-11165 50
Meadow Voles.	United States.	
W91-11536 2I	W91-11168 5B	TOTTI, C.
TERVER, D.	TIBBALS, C. H.	Seasonal Variations of Aliphatic Hydrocarbon in Sardina pilchardus (Walb.) (Teleostei: Clupei
Comparison of Two Methods for the Recovery	Hydrology of the Floridan Aquifer System in	dae) Tissues.
of Rotavirus from Mussels and Oysters. W91-10697 5A	East-Central Florida. W91-11113 2F	W91-10839 51
		TOUGIANIDOU, D.
TEUTSCH, G.	TIGCHELAAR, P. Investigations With Electrodialysis Reversal for	Detection of Poliovirus in Water by Direct Iso
Behaviour of Pathogenic Bacteria, Phages and Viruses in Groundwater During Transport and	the Treatment of Surface Water to Make-Up	lation of the RNA and Hybridization with Gen
Adsorption.	Water.	Probes.
W91-10672 5B	W91-11368 5F	W91-10666 5/

ground: Processes, Experiments and Simulation Models. W91-10674 5B TREHAN, M. F. Establishment of a Groundwater Research Data	Oxic Fluidized-Bed Treatment of Dichlorophenols. W91-11485 5D TULEYA, R. E. Sensitivity Studies of Tropical Storm Genesis	Sediments of Ise Bay. W91-11324  VALENCIA, M. J. Fact Asian Scan, Hunothetical Oil Spill Tesian.
TREHAN, M. F.	TULEYA, R. E. Sensitivity Studies of Tropical Storm Genesis	
	Sensitivity Studies of Tropical Storm Genesis	
Center for Validation of Subsurface Flow and	Using a Numerical Model.	East Asian Seas: Hypothetical Oil Spill Trajec- tories.  W91-10608 5B
Transport Models. W91-10736 2F	W91-11421 2B	VALENTINE, R. L.
TREMOLIERES, M.	TUNDISI, J. G. Perspectives for Ecological Modelling of Tropi-	Kinetics of Chemical Weathering in B Horizon
Rhine Rift Valley Groundwater-River Interac- tions: Evolution of their Susceptibility to Pollu-	cal and Subtropical Reservoirs in South Amer- ica. W91-10487 2H	Spodosol Fraction. W91-11233 5C
tion. W91-10849 5B	TUNG, C. P.	VAN DAALEN, J.  Air Quality and Deposition of Trace Elements in
TRETT, M. W. Modification of Benthic Community Structure	Study on Triple-Membrane-Separator (TMS) Process to Treat Aqueous Effluents Containing	the Province of South-Holland. W91-11248 5B
in Response to Acid-Iron Wastes Discharge. W91-10869 5C	Uranium. W91-11367 5D	VAN DE WETERING, B. G. M.
TRUDEAU, D. A.	TURNER, C. D.	North Sea Strategies. W91-10530 5G
Maps of the '400-foot,' '600-foot,' and Adjacent Aquifers and Confining Beds, Baton Rouge	Removal of Biota from Inter-Basin Transfer Water. W91-11017 5F	VAN DEN BERG, J. J.
Area, Louisiana.	W91-11017 5F TURNIPSEED, D. P.	Odour Problems with Sewage Sludge. W91-11121 5D
W91-11086 2F	Channel and Bank Stability of Wolf Creek and a	Wet Oxydation as the Alternative for Sewage
TRUPPI, L. E. Spatial Distribution of Precipitation Seasonality	Tributary at U.S. Highway 45 Near Wheeler, Prentiss County, Mississippi.	Sludge Treatment. W91-11146 5D
in the United States. W91-11414 2B	W91-11107 2E	
TSAI, C. Rise and Fall of the Potomac River Striped Bass	TWEED, F. S. Periodic Drainage of Ice-Dammed Lakes as a Result of Variations in Glacier Velocity.	VAN DER HEIJDE, P. K. M.  Establishment of a Groundwater Research Data  Center for Validation of Subsurface Flow and
Stock: A Hypothesis of the Role of Sewage. W91-11529 5C	W91-11348 2C TYLE N.	Transport Models. W91-10736 2F
TSANG, C. F.	Utility Planning Model for the Study of Air	VAN DER HOEVEN, N.
New Approach to Tracer Transport Analysis: From Fracture Systems to Strongly Heterogene-	Pollution Reduction. W91-11079 5G	LC-50 Estimates and Their Confidence Intervals Derived for Tests with Only One Concentration
ous Porous Media. W91-11554 2F	TYUS, H. M. Distribution, Habitat Use, and Growth of Age-0	with Partial Effect. W91-10930 5C
TSANIS, I. K. Summer Circulation in the Kingston Basin, Lake	Colorado Squawfish in the Green River Basin, Colorado and Utah. W91-11534 2H	VAN DER MEER, J. W. Rocking Armour Units: Number, Location and
Ontario. W91-10978 2H	UEDA, S.	Impact Velocity. W91-10786 8A
TSAR, V. V.	Water Quality Purification System for the En- closed Sea Area.	VAN DER MOLEN, W. H.
Secondary Salinization of Soils of the Dniester Delta Floodplain.	W91-10596 5G	Solution in Closed Form and a Series Solution to Replace the Tables for the Thickness of the
W91-10917 2G TSCHUI, M.	UESHIMA, H.  Flow Control Technology for Enhancement and Diverse Use of the Marine Environment.	Equivalent Layer in Hooghoudt's Drain Spacing Formula.
Accumulation of Refractory 4-Nonylphenol During Mesophilic Anaerobic Sludge Stabiliza-	W91-10607 2L	W91-11430 2G
tion. W91-10707 5D	UEYOSHI, K. Three-Dimensional Simulation of Airflow and	VAN DIJK-LOOYAARD, A. M.  Effectivity of Chlorine Dioxide to Control Aer-
TSENG, C. K.	Orographic Rain Over the Island of Hawaii. W91-10517 2B	omonas in Drinking Water Distribution Systems. W91-10677 5F
Aqueous Photolysis of Napropamide. W91-11376 5B	UKITA, M.	VAN EEKERT, M.
TSUTSUMI, H.	Evaluation of Primary Production Loads and Their Control in Enclosed Seas.	Anaerobic Biodegradability and Methanogenic Toxicity of Pulping Wastewaters.
Benthic Faunal Succession in a Cove Organical- ly Polluted by Fish Farming.	W91-10524 5G UMEHARA, T.	W91-11480 5D
W91-10554 5C	Succession of Benthic Assemblages in Wild Bird Park, a Sanctuary Established on Reclaimed	VAN GENUCHTEN, M. T. Improved Analysis of Gravity Drainage Experi-
TUCCIARELLI, T. Optimal Data Acquisition Strategy for the De-	Land in Osaka Port. W91-10606 2L	ments for Estimating Unsaturated Soil Hydraulic Functions.
velopment of a Transport Model for Ground- water Remediation.	UNO, S.	W91-11237 2G
W91-11238 5G TUDA, R.	Comparison of Nutritional Environment of Closed Coastal Seas in Western Kyushu. W91-10595 2L	VAN GRIEKEN, R.  Heavy Metal Distribution in the Godvari River Basin.
Water Quality Purification System for the En- closed Sea Area.	URBAN, W.	W91-11445 5E
W91-10596 5G	Treatment of Pulp-Bleaching Effluents by Acti- vated Sludge, Precipitation, Ozonation and Irra-	VAN KATWIJK, V.
TUFGAR, R. H. Comprehensive Water Management Strategy:	diation. W91-11491 5D	Water Supply Implication of Climate Change in Western North American Basins.
Credit River Watershed. W91-11043 6A	URUSHIGAWA, Y.	W91-11059 2E
Water Rate Structure for Demand Management	Behavior of Chlorobenzenes in Ise Bay, Estimat- ed from Their Concentrations in Various Envi-	VAN LEEUWEN, J. C.  Ecotoxicological Effects Assessment: A Com
in the Regional Municipality of Waterloo. W91-11049 6C	ronmental Media. W91-11325 5B	parison of Several Extrapolation Procedures. W91-10830 5A

VAN LENT, F.	VEZLUTSKAYA, I. V.	nolly and Gallo Ranches and the Site 300 Land-
Balance of Nutrient Losses and Gains in Sea- grass Meadows.	Distribution and Migration of Heavy Metals in the Environment of the Altai Mountains in Con-	fill Pit 6 Area.
W91-10867 2L	nection with Ecological Substantiation of the	W91-10747 5B
VAN LIER, J. B.	Katun Hydroelectric Station Project.	VOORBURG, J. H.
Future Perspectives for the Anaerobic Treat-	W91-11292 5B	Odour Problems with Sewage Sludge.
ment of Forest Industry Wastewaters.	VIEL, M.	W91-11121 5D
W91-11478 5D	Trace Element Distribution in Surficial Sedi-	VOUZARAS, A.
VAN OLPHEN, M.	ments of the Northern Tyrrhenian Sea: Contri- bution to Heavy-Metal Pollution Assessment.	Budgets of Selected Cations and Anions in Two
F-Specific RNA Bacteriophages as Model Vi-	W91-11444 5A	Forested Experimental Watersheds in Central
ruses in UV Disinfection of Wastewater. W91-10682 5D	VIESSMAN, W.	Greece.
	Dynamics of Water Policy.	W91-11550 4C
Virological Quality of Recreational Waters in the Netherlands.	W91-11212 6E	VROBLESKY, D. A.
W91-10653 5B	Water Management Issues for the Nineties.	Prospecting for Zones of Contaminated Ground-
VAN RIJN, J.	W91-10807 6D	Water Discharge to Streams Using Bottom-Sedi- ment Gas Bubbles.
Aerobic and Anaerobic Biofiltration in an Aqua-	VIGERUST, E.	W91-10951 5B
culture Unit-Nitrite Accumulation as a Result	Alternative Uses of Sludge Other than Agricul-	
of Nitrification and Denitrification.	tural. W91-11120 5E	VUKADIN, I.
W91-11547 5D		Impact of Nutrient Enrichment and Their Rela- tion to the Algal Bloom in the Adriatic Sea
VAN SCHILFGAARDE, J.	VIGNESWARAN, S.	W91-10544 5C
Water Futures. W91-10506 6B	Use of a Backflush Technique in Cross-flow Microfiltration for Treating Natural Water and	
11.00	Filter Backwash Wastewater in Water Works.	VVEDENSKII, E. L.
VAN STRIJP-LOCKEFEER, N. G. W. N. Production and Control of Reference Materials	W91-11270 5F	Method of Calculating the Technological Pa- rameters When Designing Hydraulic-Fill Dame
for Water Microbiology.	VIIKARI, L.	of Silty Soils.
W91-10623 5A	Removal of Acetate from NSSC Sulphite Pulp	W91-11284 8A
VAN VOORNEBURG, F.	Mill Condensates Using Thermophilic Bacteria. W91-10889 5D	WADA, Y.
Removal of Heavy Metals from Sewage Sludge:		Water Quality Purification System for the En-
State of the Art and Perspectives.	VILLANI, F.  Composting Raw Sewage Sludge in the Absence	closed Sea Area.
W91-11124 5D	of Bulking Agents.	W91-10596 5G
VAN VUUREN, M.	W91-11149 5E	WAGGONER, B. L.
Social and Private Returns from Wetland Pres-	VINNIKOV, K. Y.	Production Functions Relating Crop Yield
ervation. W91-11057 5G	Soil Moisture: Empirical Data and Model Re-	Water Quality and Quantity, Soil Salintiy and
	sults.	Drainage Volume.
VAN WILSON, K.  Channel and Bank Stability of Wolf Creek and a	W91-11413 2G	W91-11434 3C
Tributary at U.S. Highway 45 Near Wheeler,	VISWANATHAN, P. N.	WAGNER, B. A.
Prentiss County, Mississippi.	Ultrastructural and Biochemical Effects of Cad- mium on the Aquatic Fern Marsilea minuta	Optics of Little Sodus Bay.
W91-11107 2E	Linn.	W91-10980 2F
VAN ZOONEN, P.	W91-10829 5C	WAHDAN, A. A.
Application of HPLC Column-Switching in Pes- ticide Residue Analysis.	VIVIANI, R.	Effect of Low Salinity Water on Salt Displace
W91-11308 5A	Seasonal Variations of Aliphatic Hydrocarbons	ment in Two Soils.
WANTED W	in Sardina pilchardus (Walb.) (Teleostei: Clupei-	W91-11433 2C
VANEK, V.  Riparian Zone as a Source of Phosphorus for a	dae) Tissues. W91-10839 5B	WAI, C. M.
Groundwater-Dominated Lake.		Chromatographic Separation of Arsenic Specie
W91-10931 2H	VOELZ, N. J.  Macroinvertebrate Responses along a Complex	with Sodium Bis(trifluoroethyl)dithiocarbamat
VASSILAROS, D. L.	Regulated Stream Environmental Gradient.	Chelation. W91-10894 5/
Quantitative Determination of Acrylonitrile in	W91-10848 4A	W91-10894 5/
an Industrial Effluent by Ambient-Temperature Purge and Trap Capillary GC-MS and by	VOET, M.	WAKAHAMA, G.
Heated Purge and Trap GC-FID.	Roughness Coefficients of Watercourse Revet-	Vapor Diffusional Growth of Free-Falling
W91-11336 5A	ted With Half-Circular Concrete Pipes. Results of Field Measurements in Watercourse S 333 at	Snow Crystals Between -3 and -23 C. W91-10515
VEENSTRA, J. N.	Maarkedal.	W91-10313
In-Situ Sediment Oxygen Demand in Five	W91-11431 8B	WAKEMAN, N.
Southwestern U.S. Lakes. W91-11333 2H	VOLK, C.	Providing Access for the Public to the Shorelin
W91-11333 2H	Biodegradable Dissolved Organic Carbon	of San Francisco Bay. W91-10589 6
VEHVILAINEN, B.	(BDOC) Content of Drinking Water and Poten-	W 51-10305
Effects of Climate Change on Discharges and Snow Cover in Finland.	tial Regrowth of Bacteria. W91-10630 5F	WAKIMOTO, R. W.
W91-10964 2C		Kinematic, Dynamic, and Thermodynamic
	VOLKL, A.  Induction of Biotransformation in the Liver of	Analysis of a Weakly Sheared Severe Thunderstorm over Northern Alabama.
VENEMA, H. D. Risk-based Performance Criteria for Real-time	Eel (Anguilla anguilla L.) by Sublethal Exposure	W91-11417 2
Reservoir Operation.	to Dinitro-o-cresol: An Ultrastructural and Bio-	WAY PER TE A
W91-11275 4A	chemical Study. W91-10826 3C	WALKER, H. A. Hazard Assessment Research Strategy for
VERCELLOTTI, J. R.		Ocean Disposal.
Development of an Enzyme-Linked Immunosor-	VON WITZKE, H.	W91-11551 5
bent Assay for Geosmin. W91-10921 5F	Political Economic Model of International Pol- lution.	WATCHY A P
	W91-11016 5B	WALSBY, A. E. Microcystis Changes its Buoyancy in Respon
VESEY, G.	VONDER HAAR, S.	to the Average Irradiance in the Surface Mixe
Isolation and Identification of Cryptosporidium from Water.	Soil Vapor Survey at the LLNL Site 300 Gener-	Layer.
W91-10644 5A	al Services Area, Adjacent Portions of the Con-	W91-10895

WALSH, S. J. Occurrence of a South American Armored Cat- fish in the Hillsborough River, Florida. W91-10855 2H	WEDEL, J. H. Hydrometric Data Collection and Interpretation in the Prairie Provinces and Northwest Territo- ries.	WHITE, S. E. Adoption of Water-Savings Practices by Irriga- tors in the High Plains. W91-10821 3F
WAY TEN D	W91-11278 7A	
WALTER, R. Health Risk Assessment of Water Contaminants Using Baseline Data of Cancer Incidence in Dif- ferent Water Supply Areas.	WEESIES, G. A. RUSLE: Revised Universal Soil Loss Equation. W91-10510 2J	WHITEHEAD, P. E. Dioxin Contamination and Growth and Development in Great Blue Heron Embryos. W91-10837 5C
W91-10614 5F	WEIL, H.	
Virological Investigation of the River Elbe. W91-10652 5B	Multimethod for Pesticides in Soil at Trace Level. W91-11309 5A	WHITEHURST, I. T. Gammarus: Asellus Ratio as an Index of Organic Pollution.
WALTERS, R. A.	1171-11507	W91-11331 5A
Variability of Glacier Mass Balances in Western North America. W91-11391 2C	WELCH, A. H. Geochemical Evolution of Ground Water in Smith Creek Valley-A Hydrologically Closed Basin in Central Nevada, U.S.A.	WHITELEY, H.  Comprehensive Water Management Strategy: Credit River Watershed.
	W91-11392 2K	
WALTON, B. T.	W 91-11392 2K	W91-11043 6A
Treatability of Hazardous Chemicals in Soils: Volatile and Semivolatile Organics. W91-10712 5B	WELS, C. Streamflow Generation in a Headwater Basin on the Precambrian Shield.	WHITEMAN, J. B. Temperatures Lethal to Salvinia molesta Mitchell.
WANG, J.	W91-11349 2E	W91-11450 2H
Determination of Chlorinated Phenoxy Acid and Ester Herbicides in Soil and Water by Liquid Chromatography Particle Beam Mass Spectrometry and Ultraviolet Absorption Spec-	WENDLAND, W. M. Hydrological Aspects of the 1988 Drought in Illinois. W91-10810 2B	WHITEMAN, K. J. Geologic Framework of the Columbia Plateau Aquifer System, Washington, Oregon, and
	W91-10810 2B	Idaho.
trophotometry. W91-10893 5A	WENNBERG, L.	W91-11571 2F
W91-10893	Distribution of Halogenated Organic Com-	***************************************
Role of Phosphorus Cycling in Algal Metabo- lism and Algal Succession in Lake Donghu, China. W91-10897 5C	pounds (AOX)Swedish Transport to Surround- ing Sea Areas and Mass Balance Studies In Five Drainage Systems. W91-11506 5B	WIENER, J. G. Species Composition of Fish Communities in Northern Wisconsin Lakes: Relation to pH. W91-10725 5C
	MINISTER W. F.	
WANGERSKY, P. J.  Effect of a Spring Phytoplankton Bloom on Dissolved Copper Speciation in Bedford Basin. W91-10543  5B	WENZEL, K. D. Preconcentration of Hydrophilic and Hydropho- bic Pesticides from Aqueous Solutions and Ex- traction of Residues Using the Polymeric Sor-	WIGLEY, T. M. L. Precipitation in Britain: An Analysis of Area- Average Data Updated to 1989. W91-10973 2B
	bent Wofatit Y 77.	***************************************
WARD, J. V.	W91-11305 5A	WILEY, M.
Macroinvertebrate Responses along a Complex		Rise and Fall of the Potomac River Striped Bass
Regulated Stream Environmental Gradient. W91-10848 4A	WERNER, G. Flow-Rate Variated HPLC-/EC-Determination of Phenols.	Stock: A Hypothesis of the Role of Sewage. W91-11529 5C
WARTIOVAARA, J.	W91-11257 5A	WILKE, T. S.
Eutrophication of Pulp and Paper Wastewater		Initial Evaluation of Developmental Malforma-
Recipients. W91-11509 5C	WESSELING, J. Solution in Closed Form and a Series Solution to Replace the Tables for the Thickness of the	tion as an End Point in Mixture Toxicity Hazard Assessment for Aquatic Vertebrates.
WATSON, J. P.	Equivalent Layer in Hooghoudt's Drain Spacing	W91-10832 5C
Visual Interpretation of a Landsat Mosaic of the	Formula. W91-11430 2G	WILKINSON, C. F.
Okavango Delta and Surrounding Area.	W 31-11450 2G	Crossing the Next Meridian: Sustaining the
W91-10879 2H WEAVER, T. R.	WEST, A. S. Mechanisms of Resistance to Polychlorinated	Lands, Waters, and Human Spirit in the West. W91-11440 6E
Geochemical Evolution in the Cambrian-Ordo-	Biphenyls (PCB) in Two Species of Marine Dia-	
vician Sandstone Aquifer, Eastern Wisconsin: 1.	toms.	WILLETTS, B. B.
Major Ion and Radionuclide Distribution. W91-10953 2K	W91-11562 5C	Changes with Time of the Transport Rate of Sediment Mixtures.
2K	WEST, C. T.	W91-10988 7B
WEBER, W. J.	Assessing the Response of Emerald Lake, an	
Sorption Phenomena in Subsurface Systems: Concepts, Models, and Effects on Contaminant	Alpine Watershed in Sequoia National Park, California, to Acidification during Snowmelt by	WILLIAMS, D.  Preliminary Data Summary for the Paint For-
Fate and Transport. W91-10882 5B	Using a Simple Hydrochemical Model. W91-11594 5C	mulating Point Source Category. W91-10714 5C
W 71-10002	F	
Theoretical Study of the Significance of None- quilibrium Dissolution of Nonaqueous Phase Liquids in Subsurface Systems.	Executive Summary-Assessing the Response of Emerald Lake, An Alpine Watershed in Sequoia National Park, California, to Acidification During Snowmelt Using a Simple Hydrochemi-	WILLIAMS, H. G. Great Lakes Charter: Potential and Reality. W91-11004 6E
W91-11228 5B	cal Model.	WILLIAMS, J. E.
WEBERS, H. A. A. M.	W91-11112 7C	Pacific Salmon at the Crossroads: Stocks at Risk
Sludge Studies on Sludge Management: Strate-		from California, Oregon, Idaho, and Washing-
gic Studies on Sludge.	WHIPPLE, W.	ton.
W91-11156 5D	Future Directions for Water Resources. W91-11208 4A	W91-10834 8I
WEBSTER, R. K.		WILLIAMS, K.
Effect of Pesticide Treatments on Nontarget Or- ganisms in California Rice Paddies.	WHITCOMB, J. B. Water Use Reductions from Retrofitting Indoor Water Fixtures.	Determination of Nitroaromatics and Nitramines in Ground and Drinking Water by Wide-Bore
W91-10835 5C	W91-10811 6D	Capillary Gas Chromatography.
WEBSTER-SCHOLTEN, C. P.	WHITE, K. E.	W91-11262 5A
Remedial Investigation of the High Explosives	Report of the River Master of the Delaware	WILLIAMS, R. J.
Burn Pit Facility, Building 829 Complex, Law-	River, for the Period December 1, 1988-Novem-	Simazine Concentrations in a Stream Draining
rence Livermore National Laboratory Site 300.	ber 30, 1989.	an Agricultural Catchment.
W91-10731 5B	W91-10765 4A	W91-11364 4C

tection, Crowp basis, Southern Australia. W91-1072 2 28 WILSON, D. J. WILSON, G. V. WILSON, G. V. WILSON, G. V. Wilson's Comparison of Controlling Substances and Controlling Substance	WILLIAMSON, P. E.	WOOD, W. W.	YAMAGUCHI, K.
SOURCIAM LIP by In-sitia Aerations VL Effects of Variable Permenbilities.  Virsion François Controlling Substantines of Variable Permenbilities.  Virsion Condition of Charles and Controlling Substantines of Processes Controlling Substantines of Processes Controlling Substantines of Processes Controlling Substantines of Walker Energy Management of the Management of Walker Energy Wall Control Walker Walker Wall Control Walker Wall Control Walker Wall Control Walker Wall Control Walker Walker Walker Wall Control Walker Walker Wall Control Walker Walker Wall Control Walker Walker Walker Wall Control Walker Walker Wall Control Walker Walker Walker Walker Walker Walker Walker W		Ground-Water Control of Evaporite Deposition. W91-11438 2K	
Soul Clane Up by In-situ Aeration VI. Effects of W91-1137  W91-1137  WHSON G, V. Hydrogeochemical Processes Controlling Storm Events. Hydrogeochemical Processes Surface Transport Processes.	W91-11296 5A	WOODBURY A D	W91-10472 2B
Variable Permeabilities. W91-1037 WILSON, G. V. Hydrogeochemical Processes Controlling Substanchus Transport From an Upper Subscatchment Controlling Substance Transport From Section 1991-1995 WILSON, T. E. Rectangular Clarifiers Should Be Considered. W91-1030 WILSON, T. E. Rectangular Clarifiers Should Be Considered. W91-1031 WINDORS, J. D. WINDORS, J. D. WINDORS, J. D. WINDORS, M. B. Upstream Extraption of Four Misson Species by 101-103. WINDORS, M. B. Upstream Extraption of Four Misson Species by 101-103. WINDORS, J. D. WIN			YAMAGUCHI, Y.
WIJSON, G. V. Hydrogeochemical Processes Controlling Source Transport from an Upper Subcatchment of Walter Branch Waterided During Storm (1991-1007) Wijschief Walter Branch Waterided During Storm Events, 2 Solute Transport Processes Substantement of Walter Branch Waterided During Storm Events, 2 Solute Transport Processes Substantement of Walter Branch Waterided During Storm Events, 2 Solute Transport Processes Substantement of Walter Branch Waterided During Storm Events, 2 Solute Transport Processes, 2 W91-1098 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Walter Branch Watershed During Storm Wy1-1105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-1105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-1105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-1105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-1105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-1105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-105 WIJSON, T. E. Rectangalar Clarifiers Should Be Considered Wy1-105 WIJSON W			Seasonal Changes of Organic Carbon and Nitro-
WODDWARD, D. P. Spilleation of Upbole Data from Petroleum Rydrogenochemical Processes Controlling Substance Transport from as Upper subectachment of Walker Bransport from the College Suberview (Walker) (Walk		W91-11234 2F	
Applications of Poster Data Processes Controlling Substrafes Transport from an Upper Subcatchment of Walter Branch Waterhand During Storm Well-1987  Well-1987  Hydrogochemical Processes Controlling Substrafes Transport from an Upper Subcatchment of Walter Branch Waterhand During Storm Well-1987  Hydrogochemical Processes Controlling Substrafes Transport from an Upper Subcatchment of Walter Branch Water Branch Walter Based Processes (1988)  WILSON, T. E. Rectangalar Clariflers Should Be Considered Walter Myl-1058  WINDORS, J. D. Sensitivity of Greenback Cutthroat Trout to Acadic plf and Elevated Aluminum. Wyl-1058  WINDORS, C. Rectangalar Clariflers Should Be Considered Walter Myl-1059  WINDORS, J. D. Sonditivity of Greenback Cutthroat Trout to Acadic plf and Elevated Aluminum. Wyl-1058  WINDORS, W. R. Upstram Entirpation of Four Minnow Species Dual Processes (1991-1059)  WINDORS, W. B. Upstram Entirpation of Four Minnow Species Dual Processes (1991-1059)  WINDORS, W. R. Upstram Entirpation of Four Minnow Species Dual Processes (1991-1059)  WINDORS, W. B. Upstram Entirpation of Four Minnow Species Dual Processes (1991-1059)  WINDORS, W. B. Upstram Entirpation of Four Minnow Species Dual Processes (1991-1059)  WINDORS, C. B. Institute of Control Across (1991-1059)  WINDORS, C. B. Sangle-Doppler Radar for Estimating User State (1991-1059)  WINDORS, C. B. Woll, J. C. Williams of Walter Transfer Evaluation. Wyl-11059  WOLLOGS, D. M. Simulated Hydrologic Effects of Clarison Change in the Delaware River Basin. Wyl-11060  WOLLOGS, D. M. Simulated Hydrologic Effects of Clinatic Change in the Delaware River Basin. Wyl-11060  WOLLOGS, D. M. Simulated Ourfull Works Background to Repair and Modifications and Level Forcing on India Walterway. Wyl-1095  WOLLOGS, D. M. Ahopensed Ourfull Works Background to Repair and Modifications and Level Forcing on India Walterway. Wyl-1095  WOLLOGS, D. M. Ahopensed Ourfull Works Background to Repair and Modifications and Level Forcing on India Walterway. Wyl-1095  WOLLOGS, D. M. Ahopensed		WOODWARD, D.	
Aba Diabi (United Arab Emirates).  Aba Diabi (Unite			W 91-10004
of Walter Branch Watershed During Storn Events. I. Hydrogeochemical Processes (W9)-10007  Wyl-10007  Wyl-10008  Wyl-10008			
Events. 1. Hydrologic Transport Processes (1991-1003)  Hydrogochemical Processes Controlling Substance Transport from an Upper Substanchment of Walter Branch Waterhold During Storm Events. 2. Solute Transport Processes. (1991-1004)  Hydrogochemical Processes (1991-1005)  WILSON, T. E. Rectangular Clarifiers Should Be Considered. (1991-1123)  WINDORS, J. D. Humic Substances in Acid Surface Waters, Modelling Aluminium Binding, Contribution to Demoning of a Prairie Stream. (1991-1103)  WINDORS, J. D. WORD, J. Q. Confirmatory Chemical Analyses and Chemical Processes (1991-1103)  WINDORS, J. D. Humic Substances in Acid Surface Waters, Modelling Aluminium Binding, Contribution of Control of pt. (1991-1003)  WINDORS, J. D. WORD, J. Q. Confirmatory Chemical Analyses and Schillens, and Control of pt. (1991-1003)  WINDORS, J. D. Word, Chemical Processes (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of Control of pt. (1991-1003)  WILLIAM, J. L. Southern of C			
Hydrogeochemical Processes Controlling Subsurface Transport from an Upper Subsacichment of Walter Branch Waterhead During Storm Wys. 1-1098 dues Transport Processes.  Wys. 1-1098 dues to the State of	Events. 1. Hydrologic Transport Processes.		
Hydrogeochemical Processes Controlling Sub- surface Transport from an Upper Sub- such Support from an Upper Sub- such Support from an Upper Sub- sub- support from an Upper Sub- sub- support Support from an Upper Sub- sub- support	W91-10907 5B		
surface Transport from an Upper Subcatchment of Walker Branch Watershold During Storm Evenas. 2 Solute Transport Processes. W91-1050 WILSON, T. E. WOOR, C. Humin Substances in Acid Surface Waters, Modelling Aluminium Binding, Contribution to loaic Charge-Balance, and Control of pH. W91-1023 DWNNDERS, J. D. Penay Beck Plood-Alleviation Scheme. W91-1050 WINDERS, J. D. Penay Beck Plood-Alleviation Scheme. W91-1050 WINDERS, J. D. WILT, A. WILT, A. L. Sewage Treatment of Lagina-Aluminium Sinding of Prairie Stream. W91-1073 WISE, W. R. Charge Through Residual Oil Upon Sampling of Underlying Ground Water. W91-1073 WITI, A. L. Sewage Treatment with Plants. W91-1073 WITI, A. L. Sewage Treatment with Plants. W91-1073 WITI, A. L. Sewage Treatment with Plants. W91-1088 WILT, A. L. Sewage Treatment with Plants. W91-1088 WOLDT, W. Decision Support System for Water Transfer Evuluation. W91-11226 WOLDT, W. Decision Support System for Water Transfer Evuluation. W91-11236 WOLFF, M. E. WILLIAM Chemical Treatment of Lagina-Aluminium Sindge and Utilization of the Resulting Adsorbent-Coagulant. W91-11030 DWLFF, M. E. WILLIAM Chemical Treatment of Lagina-Aluminium Sindge and Utilization of the Resulting Adsorbent-Coagulant. W91-11231 WOLFF, M. E. WILLIAM Chemical Treatment of Lagina-Aluminium Sindge and Utilization of the Resulting Adsorbent-Coagulant. W91-11230 DWLFF, M. E. WILLIAM Chemical Treatment of Lagina-Aluminium Sindge and Utilization of the Resulting Adsorbent-Coagulant. W91-11230 DWLFF, M. E. WILLIAM Chemical Treatment of Lagina-Aluminium Sindge and Utilization of the Resulting Adsorbent-Coagulant. W91-11230 DWLFF, M. E. WILLIAM Chemical Treatment of Lagina-Aluminium Sindge and Utilization of the Resulting Adsorbent-Coagulant. W91-1030 DWLFF, M. E. WILLIAM Chemical Treatment of Lagina-Aluminium Sindge and Utilization of the Resulting Adsorbent-Coagulant. W91-1030 DWLFF, M. E. WILLIAM Chemical Treatment of Lagina-Aluminium Sindge and Utilization of the Resulting Manuer and Sewage Sindge. W91-11230 DWLFF, M. E. WILLIAM Chemi	Hydrogeochemical Processes Controlling Sub-		
WOLF, I. V. WOLF,			
WILSON, T. E. Rectangular Clarifiers Should Be Considered. W91-1025 WINDERS, J. D. Fensy Beck Flood-Alleviation Scheme. W91-1035 WINDERS, J. D. Fensy Beck Flood-Alleviation Scheme. W91-1035 Upstream Entirpsition of Four Minnow Species Due to Damming of a Prairie Stream. W91-1035 WINGER, W. R. Upstream Entirpsition of Four Minnow Species Due to Damming of a Prairie Stream. W91-1035 WINGER, W. R. Impact of Recharge Through Residual Oil Upon Sampling of Underlying Ground Water. W91-1075 WITT, A. Use of Single-Doppler Radar for Estimating Maximum Halistone Size. W91-1039 WILT, W. Decision Support System for Water Transfer Evaluation. W91-11226 WOLFE, L. V. Thermocatalytic and Chemical Treatment of Lignin-Aluminium Sindge and Utilization of the Romaling Adorbent-Coagulant. W91-11236 WOLFE, L. V. Thermocatalytic and Chemical Treatment of Lignin-Aluminium Sindge and Utilization of the Romaling Adorbent-Coagulant. W91-11039 WOLFE, L. V. Thermocatalytic and Chemical Treatment of Lignin-Aluminium Sindge and Utilization of the Romaling Adorbent-Coagulant. W91-11039 WOLMANA, A. Water and Human Health. W91-1039 WOLMANA, A. Water and Human Health. W91-11039 WOLMANA, A. Water and Human Health. W91-11039 WOLMANA, A. Water and Human Health. W91-1039 WOLMANA, A. Water and Human Health. W91-1039 WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeronoan in Drinking Water Distribution Systems. W91-1059 WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeronoan in Drinking Water Distribution Systems. W91-1059 WONDERGEM, E. Effect of Cosatal Sea Level Forcing on Indian River Bay and Rehboth Bay, Delaware. W91-1059 WONDERGEM, E. Effect of Cosatal Sea Level Forcing on Indian River Bay and Rehboth Bay, Delaware. W91-1059 WONDERGEM, E. Effect of Cosatal Sea Level Forcing on Indian River Bay and Rehboth Bay, Delaware. W91-1059 WONDERGEM, E. Effect of Cosatal Sea Level Forcing on Indian Ri		WOOF, C.	
Indicates the Charge Plasance, and Control of pH. W91-1033 Study on Model Reference Adaptive Water Policy W91-1050 Study Study N91-1050 Study Study N			W91-10603 2L
Rectangular Clarifiers Should Be Considered. W91-10933  WINDERS, J. D. Feray Beck Flood-Alleviation Scheme. W91-1093  WINDERS, J. D. Confirmatory Chemical Analyses and Solid Phase Bioassays on Sediment from the Columbia Mountaints of Four Minnow Species Dept. 1353  WINSTON, M. R. Upstream Entirpation of Four Minnow Species Dept. 1353  WINSTON, M. R. Upstream Entirpation of Four Minnow Species Dept. 1353  WINSTON, M. R. Upstream Entirpation of Four Minnow Species Dept. 1353  WINSTON, M. R. Upstream Entirpation of Four Minnow Species Dept. 1353  WINSTON, M. R. Upstream Entirpation of Four Minnow Species Dept. 1353  WINT, A. Use of Single-Doppler Radar for Estimating Maximum Halistone Size. W91-1058  WOLT, W. Decision Support System for Water Transfer Evaluation. W91-1059  WOLT, W. Decision Support System for Water Transfer Evaluation. W91-1059  WOLF, I. V. Thermocatalytic and Chemical Treatment of Lignin-Aluminium Studge and Utilization of the Robert Policy Processing Systems of Water William Systems W91-1059  WOLF, I. W. William Studge and Utilization of the Chaspeake Bay: Evidence for Organic Iodine Process W91-1059  WOLF, I. V. William Studge and Utilization of the Chaspeake Bay: Evidence for Organic Iodine Process W91-1059  WOLF, I. V. William Studge and Utilization of the Chaspeake Bay: Evidence for Organic Iodine Process W91-1059  WOLF, I. V. William Studge and Utilization of the Chaspeake Bay: Evidence for Organic Iodine Process W91-1059  WOLF, I. V. William Studge and Utilization of the Chaspeake Bay: Evidence for Organic Iodine Process W91-1059  WILLIAM Student Policy College of Condition by the Man-Mad Student Policy College of Condition by Weather Type Analysis. William Student Policy College of Condition by Weather Type Analysis. William Student Policy College of Condition of Proceed Jump. W91-1059  WOLF, M. E. Effectivity of Chlorine Dioxide to Control Action Change in the Delaware River Bain William Student Policy College of Condition Student Policy College of College of College of College of Colleg	WILSON T E		YAMAMURA, E.
WINDERS, J. D. Feasy Beck Flood-Alleviation Scheme. W91-1135 WINSTON, M. R. Upstream Extirpation of Four Minnow Species Dute to Demning of a Prairie Stream. W91-1135 WISE, W. R. Impact of Rocharge Through Residual Oil Upon Sampling of Underlying Ground Water. W91-10793 WITT, A. Use of Single-Doppler Radar for Estimating Maximum Halistone Size. 2B W91-1083 WOLDT, W. Decision Support System for Water Transfer Evaluation. W91-11226 WOLDT, W. Decision Support System for Water Transfer Evaluation. W91-11230 WOLF, M. R. WILFRAAT, K. J. North Sea Strategies. W91-1089 WOLFR, M. E. Milk River- Historical Transitions in an International Waterway. W91-11210 WOLDT, D. M. Simulated Hydrologic Effects of Climatic Companion of Precipitation by Weather Type Analysis. W91-1123 WOLDT, D. M. Simulation of Precipitation by Weather Type Analysis. W91-11230 SOURER, M. E. Effectivity of Chlorine Dioxide to Control Aeronous in Drinking Water Distribution Systems. W91-1067  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeronous in Drinking Water Distribution Systems. W91-1067  WOND, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-1068  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeronous in Drinking Water Distribution Systems. W91-1069  WOND, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-1069  WOND, A. Abbeystead Outfall Works: Background to Repair and Modifications and Lesson Learned. WOOD, A. Abbeystead Outfall Works: Background to Repair and Modifications and Lesson Learned. WOOD, A. And Abbeystead Outfall Works: Background to Repair and Modifications and Lesson Learned. WOOD, A. And Abbeystead Outfall Works: Background to Repair and Modifications and Lesson Learned. Rochamber Structure Business of Structure for Upwelling. W91-1059  WOLD C. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-1069  WOND C. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Ba			Study on Model Reference Adaptive Water Pol-
WINDERS, J. D. Fenay Beck Flood-Alleviation Scheme. W91-11365  WINSTON, M. R. Upstream Extirpation of Four Minnow Species Due to Damming of a Prairie Stream. W91-1135  GO WISE, W. R. Impact of Recharge Through Residual Oil Upon Sampling of Underlying Ground Water. W91-10793  SMITT, A. Use of Single-Doppler Radar for Estimating Maximum Halistone Size. W91-10838  WOILT, W. Decision Support System for Water Transfer Evaluation. W91-11226  WOLDT, W. Decision Support System for Water Transfer Evaluation. W91-11230  WOLDT, W. Decision Support System for Water Transfer Evaluation. W91-1126  WOLDT, W. Decision Support System for Water Transfer Evaluation. W91-1126  WOLDT, W. Decision Support System for Water Transfer Evaluation. W91-1126  WOLDT, W. Decision Support System for Water Transfer Evaluation. W91-1126  WOLDT, W. Decision Support System for Water Transfer Evaluation. W91-1126  WOLDT, W. Decision Support System for Water Transfer Evaluation. W91-1126  WOLDT, M. W91-1126  WOLDT, M. W91-1127  WOLDT, M. W91-1128  WOLDT, M. W91-1129			
Femay Beck Flood-Alleviation Scheme. 1991-1135 8  WINSTON, M. R. Upstram Estirpation of Four Minnow Species Due to Damming of a Prairie Stream. 6  WISE, W. R. Impact of Recharge Through Residual Oll Upon Sampling of Underlying Ground Water. 5B  WITT, A. Use of Single-Doppler Radar for Estimating Maximum Hallstone Size. 2B  WOLDT, W. Decision Support System for Water Transfer Evaluation. 4  WOLDT, W. Decision Support System for Water Transfer Evaluation of the Resulting Adsorbent-Coagulant. W91-1030 5D  WOLF, I. V. Thermocatalytic and Chemical Treatment of Lignia-Aluminium Studge and Utilization of the Resulting Adsorbent-Coagulant. W91-1130 5D  WOLF, M. E. Milk River: Historical Transitions in an International Waterway. W91-1039 65  WOLDT, W. Wollong, M. Water and Human Health. W91-11210 5D  WOLDT, M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-11250 5D  WOLDT, S. Simulation of Four Minnow Species of Marine Distribution Systems for Water Transfer Epidemiological Investigation into the Possible Health Effects of Basin. W91-1050 5D  WOLDER, M. E. Effectivity of Chlorine Dioxide to Control Aeronous in Drinking Water Distribution Systems. W91-1056 5T  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeronous in Drinking Water Distribution Systems. W91-1056 5T  WONNO, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-1058 5T  WOND, A. Abbeystead Outfall Works: Background to Repair and Modifications and Lesson Learned. The Recovery of Aquatic Animals in Dokais Bay, Northern Kyuthu, Japan. WONDERGEM, E. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-1058 5T  WOND, A. Abbeystead Outfall Works: Background to Repair and Modifications and Lesson Learned. The Recovery of Aquatic Animals in Dokais Bay, Northern Kyuthu, Japan. WOLDER, W. E. Effectivity of Chlorine Dioxide to Control Aeronous in Drinking Water Distribution Systems. W91-1059 5T  WOND, A. Abbeystead Outfall Works: Background to Repai	WINDERS I D		W91-10567 5G
WINSTOM, M. R. Upstram Extirpation of Four Minnow Species Due to Damming of a Prairie Stream. W91-11355  WISE, W. R. Impact of Recharge Through Residual Oil Upon Services (M91-1035)  WITT, A. Use of Single-Doppler Radar for Estimating Maximum Halistone Size. W91-10858  WOLDT, W. Decision Support System for Water Transfer Evaluation. W91-11226  AWOLDT, W. W91-11230  WOLDERGEN, M. E. WILERMAN, A. Water and Human Health. W91-11639  WOLDEAN, A. Water and Human Health. W91-11230  WOLDERGEN, E. Effectivity of Chlorine Dioxide to Control Aeronomas in Drinking Water Distribution Systems. W91-10669  WONDERGEM, E. Effect of Costall Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10695  WONDE, C. Effect of Costall Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10690  WONDA, A. Abbeystead Outfall Works: Background to Repairs and Modifications and Leasons Learner Kyanhu, Japan. W91-10695  WONDA, A. Abbeystead Outfall Works: Background to Repairs and Modifications and Leasons Learner Kyanhu, Japan. W91-10695  VANION, M. Recovery of Aquatic Animals in Dokai Bay, Necovery of Aquatic Animals in Dokai Bay, Necovery of Aquatic Animals in Dokai Bay, Polivayar. V91-10695  VANION, S. V91-10695  WINTON Sea Strategies. V91-10696  WINTON Sea Strategies. V91-10695  WULZINCER, A. Sudies for a Simultaneous Use of Liquid Manure and Sewage Siudge. V91-10679  V			YAMANAKA, Y.
WNISTON, M. R. Upstream Extirpation of Four Minnow Species Due to Damming of a Prairie Stream. W91-1033  WISE, W. R. Impact of Recharge Through Residual Oil Upon Sampling of Underlying Ground Water. W91-1093  WITT, A. Use of Single-Doppler Radar for Estimating Maximum Halistone Size. W91-10828  WOLDT, W. Decision Support System for Water Transfer Evaluation. W91-11226  WOLDT, W. Decision Support System for Water Transfer Evaluation. W91-11236  WOLF, N. Thernocatalytic and Chemical Treatment of Resulting Adsorbent-Coagulant. W91-11039  WOLF, M. E. Milk River Historical Transitions in an International Waterway. W91-11095  WOLFR, M. E. Milk River Historical Transitions in an International Waterway. W91-11095  WOLFR, M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-11050  WOLFR, M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-11050  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeronomas in Drinking Water Distribution Systems. W91-1095  WOND, K. C. Effect of Coastal Sea Level Forcing on Indian River Ray and Rebotoch Bay, Delaware. W91-1095  WOOD, A. M. Abbeystead Ourfall Works: Background to Repair and Modifications and Lessons Learner Ryauha, Japan. WOLFR, A. Albert Residual Order Revision of the Concentral Ryauha, Japan. W91-1095  WOND, K. C. Effect of Coastal Sea Level Forcing on Indian River Ray and Rebotoch Bay, Delaware. W91-1095  WOOD, A. M. Abbeystead Ourfall Works: Background to Repair and Modifications and Lessons Learner Ryauha, Japan. W91-1094  WORD, A. M. Abbeystead Ourfall Works: Background to Repair and Modifications and Lessons Learner Ryauha, Japan. W91-1094  WILFRA J. J. SWRIGHT, S. J. SWRIGHT			
Upstram Extirpation of Four Minnow Species Due to Damming of a Prairie Stream. W91-11535 60 WISE, W. R. Impact of Recharge Through Residual Oil Upon Sampling of Underlying Ground Water. W91-10793 WITT, A. Use of Single-Doppler Radar for Estimating Maximum Ralistone Size. W91-10828 2B WOLDT, W. Decision Support System for Water Transfer Evaluation. W91-11226 6A WOLF, I. V. Thermocatalytic and Chemical Treatment of Lignin-Aluminium Studge and Utilization of the Resulting Adorbent-Coagulant. W91-11530 WOLF, I. V. Thermocatalytic and Chemical Treatment of Lignin-Aluminium Studge and Utilization of the Resulting Adorbent-Coagulant. W91-11530 WOLF, I. V. WOLF, I. V. WISTER, C. F. WOLLER, M. E. Milk River Historical Transitions in an International Waterway. W91-11039 WOLMAN, A. Water and Human Health. W91-1083 WOLMAN, A. Water and Human Health. W91-1120 WOLOK, D. M. Simulation of Precipitation by Weather Type Analysis. W91-10807 WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonus in Drinking Water Distribution Systems. W91-1087 WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonus in Drinking Water Distribution Systems. W91-1087 WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonus in Drinking Water Distribution Systems. W91-1087 WONDERGEM, E. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10850 WONDERGEM, E. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10850 WONDERGEM, E. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10850 WONDERGEM, E. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10850 WONDERGEM, E. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10850 WONDERGEM, E. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10850 W91-1087 W91-1087 W91-10860 W91-10860 W91-10860 W91-10860 W91-10860 W91-10860 W91-10860 W91-10860 W91-10860 W91-10	WINSTON M. R.	W91-10753 5B	W91-10985 8B
Due to Damming of a Prairie Stream. W91-1083 WISE, W. R. Inspect of Recharge Through Residual Oil Upon Sampling of Underlying Ground Water. W91-1093 WITT, A. Use of Single-Doppler Radar for Estimating Maximum Hallstone Size. W91-1085 WOLDT, W. Docision Support System for Water Transfer Evaluation. W91-1126 WOLDT, W. Docision Support System for Water Transfer Evaluation. W91-1126 WOLF, L. V. Thermocatalyric and Chemical Treatment of Lignin-Aluminum Stadge and Utilization of the Resulting Adsorbent-Coagulant. W91-11030 WOLFE, M. E. Milk River: Historical Transitions in an Interna- tional Watervay. W91-11030 WOLFE, M. E. WOLDCK, D. M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-1156 WOLOCK, D. M. Simulation of Precipitation by Weather Type Analysis. W91-11030 WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aer- omonas in Drinking Water Distribution Systems. W91-1089 WONDE, C. Effect of Coastal Sea Level Forcing on Indian River Rhy and Rehoboth Bay, Delaware. W91-1079 WOND, K. C. Effect of Coastal Sea Level Forcing on Indian River Rhy and Rehoboth Bay, Delaware. W91-1093 WOND, M. Abbeystead Outfall Works: Background to Re- pairs and Modifications and Lessons Learned. WOND, M. Abbeystead Outfall Works: Background to Re- pairs and Modifications and Lessons Learned. WOND, M. Abbeystead Outfall Works: Background to Re- pairs and Modifications and Lessons Learned. W91-10530 WONDERCENT, P. W91-10530 WONDERCEM, E. Effectivity of Chlorine Dioxide to Control Aer- omonas in Drinking Water Distribution Systems. W91-1054 WOND, M. Abbeystead Outfall Works: Background to Re- pairs and Modifications and Lessons Learned. W91-10530 WONDERCEM, E. W91-10530 WONDERCEM, E. Effectivity of Chlorine Dioxide to Control Aer- omonas in Drinking Mater Distribution Systems. W91-10540 W91-10550 W91-10550 W91-10570 W91-1057	Upstream Extirpation of Four Minnow Species	WRIGHT, S. J.	
WISE, W. R. Impact of Recharge Through Residual Oil Upon Sampling of Underlying Ground Water. W91-10793  WITT, A. Use of Single-Doppler Radar for Estimating Maximum Halistone Size. W91-1088  WU, J. Decision Support System for Water Transfer Evaluation. W91-10896  WU, J. Decision Support System for Water Transfer Evaluation. W91-10896  WU, J. Decision Support System for Water Transfer Evaluation. W91-10896  WU, J. Decision Support System for Water Transfer Evaluation. W91-10896  WU, J. Decision Support System for Water Transfer Evaluation. W91-10896  WU, J. Decision Support System for Water Transfer Evaluation. W91-1089  WU, J. Decision Support System for Water Transfer Evaluation. W91-1089  WU, J. North Sea Strategies. W91-1089  WURSTER, C. F. Mechanisms of Resistance to Polychlorinated Biphersyle (PCB) in Two Species of Marine Dis- toms. W91-11562  WURZINGER, A. Studies for a Simultaneous Use of Liquid Manure and Sewage Sludge. W91-11157  WURZINGER, A. Water and Human Health. W91-11210  WOLDCK, D. M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-11080  WORNAN, A. Water and Human Health. W91-10190  WYER, M. Results of the First Pilot-Scale Controlled Cohort Epidemiological Investigation into the Possible Health Effects of Bathing in Seawater at Langland Bay, Swassea. W91-1059  WONG, K. C. Effectivity of Chlorine Dioxide to Control Aer- omonas in Drinking Water Distribution Systems. W91-10699  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-1059  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-1059  WONG, A. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-1059  WOOD, A. M. Abbeystead Outfall Works: Background to Re- pairs and Modifications and Lessons Learned. Robert Strategies. W91-1050  W91-105			
WISE, W. R. Impact of Recharge Through Residual Oil Upon Sampling of Underlying Ground Water. W91-1079  WITT, A. Use of Single-Doppler Radar for Estimating Maximum Hailstone Size. W91-1083  W91-1083  WOLDT, W. Decision Support System for Water Transfer Evaluation. W91-11236  WOLF, I. V. Thermocatalytic and Chemical Treatment of Lignin-Aluminium Sludge and Utilization of the Resulting Adsorbent-Coagulant. W91-11530  WOLFE, M. E. Milk River Historical Transitions in an International Waterway. W91-11030  WOLMAN, A. Water and Human Health. W91-11210  WOLDOCK, D. M. Simulation of Precipitation by Weather Type Analysis. W91-11230  WONDERCEM, E. Effectivity of Chlorine Dioxide to Control Actomonas in Drinking Water Distribution Systems. W91-10869  WONDERCEM, E. Effectivity of Chlorine Dioxide to Control Actomonas in Drinking Water Distribution Systems. W91-10879  WONDERCEM, E. W91-10520  WONDERCEM, E. Effectivity of Chlorine Dioxide to Control Actomonas in Drinking Water Distribution Systems. W91-10677  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-1087  WOND, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. W91-1089  WONDA, M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. W91-1089  WONDA, M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. W91-1089  WONDA, M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. W91-1089  WONDA, M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. W91-1089  WONDA, M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. W91-1089  WONDA, M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. W91-1089  WONDA, M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. W91-1089  W91-1089  W91-1089  W91-1089  W91-1089  W91-1089  W91-1089  W91-1089	W91-11535 6G		
Impact of Recharge Through Restaud Iol Upon Sampling of Underlying Ground Water. W91-10793  Sampling of Underlying Ground Water. W91-1079  WITT, A. Use of Single-Doppler Radar for Estimating Maximum Hailstone Size. W91-1088  WU, J. Iodine Chemistry in the Water Column of the Chesspeake Bay: Evidence for Organic Iodine Chesspeake Bay: Evidence for Organic Iodin		W91-10986 SE	
W91-10793 WITT, A. Use of Single-Doppler Radar for Estimating Maximum Hailstone Size. W91-1083 2B WULDT, W. Decision Support System for Water Transfer Evaluation. W91-11286 AWOLF, I. V. Thermocatalytic and Chemical Treatment of Ligain-Aluminium Studge and Utilization of the Resulting Adsorbent-Coagulant. W91-11030 WOLFE, M. E. Milk River: Historical Transitions in an International Waterway. W91-11039 GE WOLMAN, A. Water and Human Health. W91-11211 WOLDCK, D. M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-11060 Smulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-11060 Simulation of Precipitation by Weather Type Analysis. W91-1077 WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-1087 WONDERGEM, E. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-1095 WONDO, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. Activers May and Rehoboth Bay, Delaware. W91-1095 VAMADA, M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. Activated Study on Adsorption Mechanism of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Diations of RNA-F-Specific Coliphages and Poliovirus Activated Sludge Process. W91-1054 VANCIR, R. Comparison of Adsorption Mechanism of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Diations of RNA-F-Specific Coliphages and Poliovirus Activated Sludge Process. W91-1054 VANCIR, R. Comparison of Marine Diation of RNA-F-Specific Coliphages and Poliovirus Activated Sludge Process. W91-1054 VANCIR, R. Comparison of Adsorption Mechanism of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Diations of RNA-F-Specific Coliphages and Poliovirus Activated Sludge Process. W91-1055 VANO, T. Meteorology and Oceanography in the Se Growth of Clinical Isolates of Astrovirus in a Comparison of Amperometric and UV-Spectr			
WITT, A.  Use of Single-Doppler Radar for Estimating Maximum Hailstone Size.  W91-10838  2B  WOLDT, W. Decision Support System for Water Transfer Evaluation.  W91-11226  6A  WOLF, I. V. Thermocatalytic and Chemical Treatment of Lignin-Aluminium Studge and Utilization of the Resulting Adsorbent-Coagulant.  W91-11503  WOLFE, M. E. Milk River. Historical Transitions in an International Waterway.  W91-11039  WOLMAN, A. Water and Human Health. W91-11211  WOLOCK, D. M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin.  W91-11260  WYER, M. Simulation of Precipitation by Weather Type Analysis. W91-11250  WONDERGEM, E. Effectivity of Clotrine Dioxide to Control Aeronomas in Drinking Water Distribution Systems. W91-10677  WONG, K. C. Effects of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-1069  WODD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.			
Use of Single-Doppler Radar for Estimating Maximum Hailstone Size.  W91-10588  2B  WOLDT, W. Decision Support System for Water Transfer Evaluation.  W91-11226  WOLF, I. V. Thermocatalytic and Chemical Treatment of Ligini-Aluminium Sludge and Utilization of the Resulting Adsorbent-Coagulant.  W91-11503  WOLF, M. E. Milk River: Historical Transitions in an International Waterway.  W91-11039  WOLFR, M. E. Milk River: Historical Transitions in an International Waterway.  W91-11039  WOLFR, M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin.  W91-11250  WONDERGM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems.  W91-1089  WONDERGM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems.  W91-10494  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  ABULTA.  WUSTER, S. CF. Milk River: Historical Transitions in an International Waterway.  W91-10550  WURZINGER, A. Sunultaneous Use of Liquid Chort Epidemiological Investigation into the Possible Health Effects of Bahing in Seawater at Langland Bay, Swansea.  W91-1089  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems.  W91-1089  WONDERGEM, E. Effectivity of Colostal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware.  W91-10894  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.		W 31-11400	
Maximum Hailstoné Size. W91-10858 2B WOLDT, W. Decision Support System for Water Transfer Evaluation. W91-11226 6A WOLF, L. V. Thermocatalytic and Chemical Treatment of Ligain-Aluminium Sludge and Utilization of the Resulting Adsorbent-Coagulant. W91-11503 5D WOLFE, M. E. Milk River: Historical Transitions in an Interna- tional Waterway. W91-11039 6E WOLMAN, A. Water and Human Health. W91-11211 5F WOLOCK, D. M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-11060 5C Simulation of Precipitation by Weather Type Analysis. W91-11230 2B WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Ac- monoas in Drinking Water Distribution Systems. W91-10667 5F WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10954 5C Robert System for Water Transfer Evaluation. W91-10530 5G WURSTER, C. F. WURZINGER, A. Studies for a Simultaneous Use of Liquid Manure and Sewage Sludge. W91-11059 5E WYER, M. Results of the First Pilot-Scale Controlled Cholort Epidemiological Investigation into the Possible Health Effects of Bathing in Seawater at Langland Bay, Swansea. W91-10669 5C WNN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10809 5C W91-10795 5C W91-10795 5C W91-10795 5C W91-10795 5C W91-10809 6C WYRN-JONES, A. P. Field Sampling of Residual Aviation Gasoline in Sandy Soil. W91-10809 5C W91-10839 5C W91-10839 5C WYRN-JONES, A. P. Thermocatallytic and Chemical Treatment of Ligain-Aduminium Sludge and Elevated Aluminum. W91-11531 5C Comparative Study on Adsorption Mechanism of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Dis- tons. W91-10659 5C WYRN-Field Sampling of Residual Aviation Gasoline in Sampling of Residual Aviation Gasoline in Sandy Soil. W91-10795 5A W91-10859 5C W91-10859 5C W91-10859 5C WYRN-GRE, A. Studies for a Simultaneous Use of Liquid Manure and Sewage Sludge. W91-11531 VANO, T. Meteorology and Oceanography in the Set Inland Sea. W91-10859 5C W91-			W91-10542
W91-1083 WOLDT, W. Decision Support System for Water Transfer Evaluation. W91-11226 6A WOLF, L.V. Thermocatalytic and Chemical Treatment of Ligain-Aluminium Sludge and Utilization of the Resulting Adsorbent-Coagulant. W91-1153  WOLFE, M. E. Milk River: Historical Transitions in an Interna- tional Waterway. W91-11039 6E WOLMAN, A. Water and Human Health. W91-11211 5F WOLOCK, D. M. Simulated Hydrologic Effects of Change in the Delaware River Basin. W91-11230  WONDERGEM, E. Simulation of Precipitation by Weather Type Analysis. W91-1030  WONDERGEM, E. Effectivity of Chronical Countrol Aer- monas in in the Prespiration of Viral RNA. W91-1032  WONDERGEM, E. Effectivity of Chronical Countrol Aer- monas in an Interna- tional Waterway. W91-1032  WONDERGEM, E. Effectivity of Chronical Countrol Aer- monas in an Interna- tional Waterway. W91-1030  ST  WYLR, M. Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan. W91-10573  YASUOKA, Y. Feled Sampling of Residual Aviation Gasoline in Sandy Soil. W91-1095  YASUOKA, Y. Feled Sarrey and Hydraulic Study of 'Aoshio' Tokyo Bay.  VASUOKA, Y. Feled Sarrey and Hydraulic Study of 'Aoshio' Tokyo Bay.  VASUOKA, Y. Feled Sarrey and Hydraulic Study of 'Aoshio' Tokyo Bay.	Maximum Hailstone Size.		VANCTE, R.
Decision Support System for Water Transfer Evaluation. W91-11226 6A  WOLF, I. V. Thermocatalytic and Chemical Treatment of Lignin-Adminium Studge and Utilization of the Resulting Adsorbent-Coagulant. W91-11303 5D  WOLFE, M. E. Milk River: Historical Transitions in an International Waterway. W91-11039 6E  WURZINGER, A. Studies for a Simultaneous Use of Liquid Manure and Sewage Sludge. W91-11211 5F  WOLMAN, A. Water and Human Health. W91-11211 5F  WOLOCK, D. M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-11230 5C  Simulation of Precipitation by Weather Type Analysis. W91-11230 2B  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10795  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Leasons Learned. W91-1078  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Leasons Learned. W91-1078  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Leasons Learned.	W91-10858 2B	Forms.	Sensitivity of Greenback Cutthroat Trout to
Evaluation. W91-11226 6A WOLF, I. V. Thermocatalytic and Chemical Treatment of Lignin-Aluminium Studge and Utilization of the Resulting Adsorbent-Coagulant. W91-11503 5D WOLFE, M. E. Milk River: Historical Transitions in an International Waterway. W91-11039 6E WOLMAN, A. Water and Human Health. W91-11211 5F WOLOCK, D. M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-11230 5D WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10669 XIE, Y. WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-1095 5T WOND, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-1094  YAMADA, M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. Northesa Strategies. W91-10830 5G WURSTER, C. F. Mechanisms of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Distons. W91-11562 5C WURSTER, C. F. Mechanisms of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Distons. W91-11562 5C WURSTER, C. F. Mechanisms of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Distons. W91-10694 5C WURSTER, C. F. Mechanisms of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Distons. W91-1052 5C WURSTER, C. F. Mechanisms of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Distons. W91-10694 5C WURSTER, C. F. Mechanisms of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Distons. W91-1052 5C WURSTER, C. F. Mechanisms of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Distons. W91-1052 5C WURSTER, C. F. Mechanisms of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Distons. W91-1055 5C WURSTER, C. F. Mechanisms of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Distons. W91-1050 5C WURSTER, C. F. Mechanisms of Resistance to Polychlorinated	WOLDT, W.	W91-10496 2L	
W91-11226  WOLF, I. V. Thermocatalytic and Chemical Treatment of Lignin-Aluminium Studge and Utilization of the Resulting Adsorbent-Coagulant. W91-11503  WOLFE, M. E. Milk River: Historical Transitions in an International Waterway. W91-11039  GE  WOLMAN, A. Water and Human Health. W91-11211  WOLOCK, D. M. Simulated Hydrologic Effects of Change in the Delaware River Basin. W91-11060  SC Simulation of Precipitation by Weather Type Analysis. W91-11230  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10667  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10934  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  W91-10530  WURSTER, C. F. Mechanisms of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Diatons. W91-1062  WURZINGER, A. Studies for a Simultaneous Use of Liquid Manure and Sewage Sludge. W91-101562  WYER, M. Results of the First Pilot-Scale Controlled Cohort Epidemiological Investigation into the Possible Health Effects of Bathing in Seawater at Langland Bay, Swansea. W91-10669  WNN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10669  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10530  YABUMOTO, Y. Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan. W91-10573  YASUDA, Y. Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay. Valuada, M. Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan. W91-10573  YASULA, Y. Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay. Valuada, Y. Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay. Valuada, Y. Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay.		WULFFRAAT, K. J.	W91-11531
WOLF, I. V. Thermocatalytic and Chemical Treatment of Ligain-Aluminium Sludge and Utilization of the Resulting Adsorbent-Coagulant. W91-11303 5D WOLF, M. E. Milk River: Historical Transitions in an International Waterway. W91-11039 6E WOLMAN, A. Water and Human Health. W91-11211 5F WOLOCK, D. M. Simulated Hydrologic Effects of Change in the Delaware River Basin. W91-11060 5C Simulation of Precipitation by Weather Type Analysis. W91-11230 2B WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677 5F WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10590 5C WOND, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. W91-10590 5C WALFER, C. F. Mechanisms of Resistance to Polychlorinated Biphenyls (PCB) in Two Species of Marine Diatoms. W91-11502 5C WURZINGER, A. Studies for a Simultaneous Use of Liquid Manure and Sewage Sludge. W91-11059 5E WYER, M. Results of the First Pilot-Scale Controlled Cohort Epidemiological Investigation into the Possible Health Effects of Bathing in Seawater at Langland Bay, Swansea. W91-10699 5A W91-10520 7AO, S. Comparison of Amperometric and UV-Spectr Postometric Monitoring in the HPLC Analys of Pesticides. W91-10699 5A W91-10699 5A W91-10690 5A W91			
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Lignin-Aluminium Sludge and Utilization of the Resulting Adsorbent-Coagulant. W91-11503  WOLFE, M. E. Milk River: Historical Transitions in an International Waterway. W91-1039  6E  WOLMAN, A. Water and Human Health. W91-11211  FOR WOLOCK, D. M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-11060  Simulation of Precipitation by Weather Type Analysis. W91-11230  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677  WONDE, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10550  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. Amanage and Sewage Sludge. W91-1157  Studies for a Simultaneous Use of Liquid Manure and Sewage Sludge. W91-1157  Studies for a Simultaneous Use of Liquid Manure and Sewage Sludge. W91-1157  EWYER, M. Results of the First Pilot-Scale Controlled Cohort Epidemiological Investigation into the Possible Health Effects of Bathing in Seawater at Langland Bay, Swansea. W91-11366  SC WYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10669  YASEEN, H. A. Bacteriological Suitability of Water from Bass Wells for Drinking. W91-1089  YASUDA, Y. Drag on Vertical Sill of Forced Jump. W91-1095  YASUDA, Y. Drag on Vertical Sill of Forced Jump. W91-1095  YASUJA, Y. Drag on Vertical Sill of Forced Jump. W91-1095  YASUJA, Y. Drag on Vertical Sill of Forced Jump. W91-1095  YASUJA, Y. Drag on Vertical Sill of Forced Jump. W91-1095  YASUJA, Y. Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay. Northern Kyushu, Japan.			
Resulting Adsorbent-Coagulant. W91-11503 SD WOLFE, M. E. Milk River: Historical Transitions in an International Waterway. W91-11039 6E WOLMAN, A. Water and Human Health. W91-11211 SF WOLOCK, D. M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-11060 SC Simulation of Precipitation by Weather Type Analysis. W91-11230 WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677 WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10494 WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. AWILTINGER, A. Studies for a Simultaneous Use of Liquid Manure and Sewage Sludge. W91-11562 WYER, M. Simulation of Precipitation by Weather Type Analysis. W91-11060 SC WYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10699 ST WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677 WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10540  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.			
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WOLFE, M. E. Milk River: Historical Transitions in an International Waterway. W91-11039 6E  WOLMAN, A. Water and Human Health. W91-11211 5F  WOLOCK, D. M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-11060 5C Simulation of Precipitation by Weather Type Analysis. W91-11230 2B  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10550  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. WIRZINGER, A. Studies for a Simultaneous Use of Liquid Manure and Sewage Sludge. W91-1157  Studies for a Simultaneous Use of Liquid Manure and Sewage Sludge. W91-11055  WYRM, M. Results of the First Pilot-Scale Controlled Cohort Epidemiological Investigation into the Possible Health Effects of Bathing in Seawater at Langland Bay, Swansea. W91-10665  WYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10669  WYN, JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10669  WYR, M. Results of the First Pilot-Scale Controlled Cohort Epidemiological Investigation into the Possible Health Effects of Bathing in Seawater at Langland Bay, Swansea. W91-1056  WYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10669  WYAO, S. Comparison of Amperometric and UV-Specter Photometric Monitoring in the HPLC Analys of Pesticides. W91-1079  WYASSER, H. A. Bacteriological Suitability of Water from Bast Wells for Drinking. W91-10629  W91-10629  WYASURA. Results of the First Pilot-Scale Controlled Control Aeromatics in Exception of Agrandian Seawater at Langland Bay, Swansea. W91-1079  WYASSER, H. A. Bacteriological Suitability of Water from Bast Wells for Drinking. W91-10629  W91-10629  YASUDA, Y. Drag on Vertical Sill of Forced Jump.	W91-11503 5D		
Milk River: Historical Transitions in an International Waterway.  W91-11039  6E  WOLMAN, A.  Water and Human Health.  W91-11211  5F  WOLOCK, D. M.  Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin.  W91-11060  5C  Simulation of Precipitation by Weather Type Analysis.  W91-11230  WONDERGEM, E.  Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems.  W91-10679  WONG, K. C.  Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware.  W91-10550  WOOD, A. M.  Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.		WIIDZINGED A	
Manure and Sewage Sludge.  W91-11039  6E  WOLMAN, A.  Water and Human Health. W91-11211  SF  WOLOCK, D. M.  Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-11060  SC  Simulation of Precipitation by Weather Type Analysis. W91-11230  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10550  Manure and Sewage Sludge. W91-11157  SE  WYER, M. Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.  Meteorology and Oceanography in the Se Inland Sea. W91-10520  YAO, S. Comparison of Amperometric and UV-Spectr photometric Monitoring in the HPLC Analysis of Pesticides. W91-11306  SWYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10669  WNN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10699  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10550  YABUMOTO, Y. Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.  YASUOKA, Y. Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay.			VANO T
WOLMAN, A. Water and Human Health. W91-11211  WOLOCK, D. M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-11366  SC Simulation of Precipitation by Weather Type Analysis. W91-11230  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10550  W91-10550  W91-10579  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  W91-10570  WYER, M. Results of the First Pilot-Scale Controlled Cohort lepidemiological Investigation into the Possible Health Effects of Bathing in Seawater at Langland Bay, Swansea. W91-11366  WYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10669  WYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-1069  WYSER, M. Results of the First Pilot-Scale Controlled Cohort lepidemiological Investigation into the Possible Health Effects of Bathing in Seawater at Langland Bay, Swansea. W91-11366  WYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-1069  WYASUBA, V. Field Sampling of Residual Aviation Gasoline in Sandy Soil. W91-1095  YAO, S. Comparison of Amperometric and UV-Spectr photometric Monitoring in the HPLC Analys of Pesticides. W91-11306  WYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-1069  WYASUBA, V. Drag on Vertical Sill of Forced Jump. W91-10985  YASUBA, V. Drag on Vertical Sill of Forced Jump. W91-10573  YASUBA, V. Field Sampling of Animals in Dokai Bay, Northern Kyushu, Japan. W91-10573  YASUBA, V. Field Sampling of Animals in Dokai Bay, Northern Kyushu, Japan. W91-10573  YASUBA, V. Field Sampling of Animals in Dokai Bay, Northern Kyushu, Japan. W91-10573  YASUBA, V. Field Survey and Hydraulic Study of 'Aosh			Meteorology and Oceanography in the Set
Water and Human Health. W91-11211 5F WOLOCK, D. M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-11060 5C Simulation of Precipitation by Weather Type Analysis. W91-11230 2B WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677 WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10494 WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. WSL, M. Results of the First Pilot-Scale Controlled Cohort Epidemiological Investigation into the Possible Health Effects of Bathing in Seawater at Langland Bay, Swansea. W91-11366 SC WYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10669 WYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10669 WYN-JONES, A. P. Field Sampling of Residual Aviation Gasoline in Sandy Soil. W91-10795 SA W91-10985 YASUDA, Y. Drag on Vertical Sill of Forced Jump. W91-10985 YASUI, H. Environmental Management of the Seto Inla Sea. W91-10573 YASUOKA, Y. Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay. Northern Kyushu, Japan.  YASUOKA, Y. Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay.		W91-11157 5E	Inland Sea.
W91-11211  WOLOCK, D. M. Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin. W91-11060  SC Simulation of Precipitation by Weather Type Analysis. W91-11230  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10494  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  Kesuits of the First Photoscale Control Quidelinological Investigation into the Possible Health Effects of Bathing in Seawater at Langland Bay, Swansea. W90-11306  SC  WYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10669  XIE, Y. Field Sampling of Residual Aviation Gasoline in Sandy Soil. W91-10795  YANG. S. Comparison of Amperometric and UV-Spectr photometric Monitoring in the HPLC Analys of Pesticides. W91-11306  SWYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10669  XIE, Y. Field Sampling of Residual Aviation Gasoline in Sandy Soil. W91-10795  YANG. S. Comparison of Amperometric and UV-Spectr photometric Monitoring in the HPLC Analys of Pesticides. W91-11306  SAMPLIANCE OF STAND			W91-10520 2
Cohort Epidemiological Investigation into the Possible Health Effects of Bathing in Seawater at Langland Bay, Swansea.  W91-11060  SC Simulation of Precipitation by Weather Type Analysis. W91-11230  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10494  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  Comparison of Amperometric and UV-Spectr photometric Monitoring in the HPLC Analysis of Pesticides. W91-11366  SC  WYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10669  XIE, Y. Field Sampling of Residual Aviation Gasoline in Sandy Soil. W91-10795  YASUDA, Y. Drag on Vertical Sill of Forced Jump. W91-1083  YASUDA, Y. Drag on Vertical Sill of Forced Jump. W91-1085  YASUI, H. Environmental Management of the Seto Inla Sea. W91-10573  YASUOKA, Y. Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay. Tokyo Bay.			YAO, S.
Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin.  W91-11060  SC Simulation of Precipitation by Weather Type Analysis. W91-11230  W91-11230  W91-11230  W91-11230  W91-10669  W91-11230  W91-10669  XIE, Y. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10679  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10795  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10494  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  W91-10530  At Langland Bay, Swansea. W91-11366  SC  WYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10669  XIE, Y. Field Sampling of Residual Aviation Gasoline in Sandy Soil. W91-10795  YASUDA, Y. Drag on Vertical Sill of Forced Jump. W91-10850  YASUDA, Y. Drag on Vertical Sill of Forced Jump. W91-10875  W91-10570  YASUDA, Y. Environmental Management of the Seto Inla Sea. W91-10573  YASUOKA, Y. Field Sampling of Residual Aviation Gasoline in Sandy Soil. W91-10795  YASUDA, W. Environmental Management of the Seto Inla Sea. W91-10573  YASUOKA, Y. Field Sampling of Residual Aviation Gasoline in Sandy Soil. W91-10899  YASUDA, W. Field Sampling of Augustic Animals in Dokai Bay, Soil Potential Sill of Forced Jump. W91-10895  YASUDA, Y. Field Sampling of Residual Aviation Gasoline in Sandy Soil. W91-10899  YASUDA, Y. Field Sampling of Residual Aviation Gasoline in Sandy Soil. W91-10899  YASUDA, Y. Field Sampling of Residual Aviation Gasoline in Sandy Soil. W91-10899  YASUDA, Y. Field Sampling of Pesticides. W91-10699  YASUDA, Y. Field Sampling of Pestici	WOLOGE D M		Comparison of Amperometric and CV-Specific
Change in the Delaware River Basin. W91-11060  Simulation of Precipitation by Weather Type Analysis. W91-11230  WNN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10669  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10494  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  W91-11366  WYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. W91-10669  XIE, Y. Field Sampling of Residual Aviation Gasoline in Sandy Soil. W91-10795  YASUMA, Y. Environmental Management of the Seto Inla Sea. W91-10573  YASUMA, M. Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.  YAMADA, M. Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.  YASUOKA, Y. Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay.			photometric monitoring in the first Analys
WYN-JONES, A. P.  Simulation of Precipitation by Weather Type Analysis. W91-11230 2B  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10494  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  WYN-JONES, A. P. Growth of Clinical Isolates of Astrovirus in a Cell Line and the Preparation of Viral RNA. Bacteriological Suitability of Water from Bast Wells for Drinking. W91-10669  XIE, Y. Field Sampling of Residual Aviation Gasoline in Sandy Soil. W91-10795  YASUDA, Y. Drag on Vertical Sill of Forced Jump. W91-10985  YASUI, H. Environmental Management of the Seto Inla Sea. W91-10573  YASUOKA, Y. Field Sampling of Residual Aviation Gasoline in Dokai Bay, Drag on Vertical Sill of Forced Jump. W91-10795  YASUI, H. Environmental Management of the Seto Inla Sea. W91-10573  YASUOKA, Y. Field Sampling of Residual Aviation Gasoline in Dokai Bay, Drag on Vertical Sill of Forced Jump. W91-10795  YASUI, H. Environmental Management of the Seto Inla Sea. W91-10573  YASUOKA, Y. Field Sampling of Residual Aviation Gasoline in Dokai Bay, Drag on Vertical Sill of Forced Jump. W91-10795  YASUOKA, Y. Field Sampling of Residual Aviation Gasoline in Dokai Bay, Drag on Vertical Sill of Forced Jump. W91-10795  YASUOK, Y. Field Sampling of Residual Aviation Gasoline in Dokai Bay, Drag on Vertical Sill of Forced Jump. W91-10795  YASUOK, Y. Field Sampling of Residual Aviation Gasoline in Dokai Bay, Drag on Vertical Sill of Forced Jump. W91-10795  YASUOK, Y. Field Sampling of Residual Aviation Gasoline in Dokai Bay, Drag on Vertical Sill of Forced Jump. W91-10795  YASUOK, Y. Field Sampling of Residual Aviation Gasoline in Dokai Bay, Drag on Vertical Sill of Forced Jump. W91-10795  YASUOK, Y. Field Sampling of Residual Aviation Gasoline in Dokai Bay, Drag on Vertical Sill of Forced Jump. W91-10795  YASUOK, Y. Field Sampling of Re	Change in the Delaware River Basin.	W91-11366 5C	
Simulation of Precipitation by Weather Type Analysis. W91-10230  WONDERGEM, E. Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems. W91-10677  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10550  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  Are the Preparation of Viral RNA. W91-10669  XIE, Y. Field Sampling of Residual Aviation Gasoline in Sandy Soil. W91-10795  YASUDA, Y. Drag on Vertical Sill of Forced Jump. W91-10829  YASUI, H. Environmental Management of the Seto Inlance. W91-10573  YASUOKA, Y. Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay. Tokyo Bay.	W91-11060 5C	WYN-JONES, A. P.	
Analysis.  W91-11230  2B  W91-10669  W91-10669  XIE, Y.  Field Sampling of Residual Aviation Gasoline in Sandy Soil.  W91-10677  WONG, K. C.  Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware.  W91-10494  WOOD, A. M.  Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  W91-10695  XIE, Y.  Field Sampling of Residual Aviation Gasoline in Sandy Soil.  W91-10795  YASUDA, Y.  Drag on Vertical Sill of Forced Jump.  W91-1085  YASUL, H.  Environmental Management of the Seto Inla Sea.  W91-10573  YASUUKA, Y.  Field Survey of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.  YASUUKA, Y.  Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay.	Simulation of Precipitation by Weather Type	Growth of Clinical Isolates of Astrovirus in a	Destarial animal Cuitability of Water from Bases
WONDERGEM, E.  Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems.  W91-10677  WONG, K. C.  Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware.  W91-10550  WOOD, A. M.  Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  XIE, Y.  Field Sampling of Residual Aviation Gasoline in Sandy Soil.  W91-10795  To Agumotro, Y.  Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.  W91-10629  YASUDA, Y.  Drag on Vertical Sill of Forced Jump.  W91-1085  YASUL, H.  Environmental Management of the Seto Inla Sea.  W91-10573  YASUDKA, Y.  Field Sumyling of Residual Aviation Gasoline in Dokai Bay, Drag on Vertical Sill of Forced Jump.  W91-10629  YASUDA, Y.  Environmental Management of the Seto Inla Sea.  W91-10573  YASUDKA, Y.  Field Sumyling of Residual Aviation Gasoline in Dokai Bay, Drag on Vertical Sill of Forced Jump.  W91-10629  YASUDA, Y.  Environmental Management of the Seto Inla Sea.  W91-10573  YASUDKA, Y.  Field Sumyling of Residual Aviation Gasoline in Dokai Bay, Drag on Vertical Sill of Forced Jump.  W91-10629	Analysis.		Walls for Deinking
Effectivity of Chlorine Dioxide to Control Aeromonas in Drinking Water Distribution Systems.  W91-10677  WONG, K. C.  Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10934  WOOD, A. M.  Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  Field Sampling of Residual Aviation Gasoline in Sandy Soil.  W91-10795  TABUMOTO, Y.  Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.  W91-10550  YASUIA, Y.  Environmental Management of the Seto Inla Sea. W91-10573  W91-10573  YASUOKA, Y. Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay.	W91-11230 2B	W91-10009	W91-10629 5.
Effectivity of Chlorine Dioxide to Control Are omnons in Drinking Water Distribution Systems. W91-10677  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10494  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. Page 18 Sandy Soil. W91-10795  YABUMOTO, Y. Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan. Sea. W91-10573  YAMADA, M. Recovery of Aquatic Animals in Dokai Bay, Pield Survey and Hydraulic Study of 'Aoshio' Tokyo Bay. Tokyo Bay.	WONDERGEM, E.		YASUDA, Y.
W91-10677  WONG, K. C. Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10494  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  W91-1075  YABUMOTO, Y. Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.  YAMADA, M. Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.  YAMUMA, M. Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.  YASUUKA, Y. Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay.			Drag on Vertical Sill of Forced Jump.
WONG, K. C.  Effect of Coastal Sea Level Forcing on Indian River Bay and Rehoboth Bay, Delaware. W91-10494  WOOD, A. M.  Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  YABUMOTO, Y.  Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.  YASUI, H.  Environmental Management of the Seto Inla Sea.  W91-10573  YASUOKA, Y.  Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay.			W91-10985
WONG, A. M.  River Bay and Rehoboth Bay, Delaware. W91-10494  WOOD, A. M.  Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  Northern Kyushu, Japan.  YAMADA, M.  Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.  W91-10573  YASUOKA, Y.  Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay.		VARIMOTO V	YASUL, H.
River Bay and Rehoboth Bay, Delaware. W91-10494  WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned. Northern Kyushu, Japan.  Northern Kyushu, Japan.  Northern Kyushu, Japan.  Sea. W91-10573  W91-10573  W91-10573  YASUOKA, Y. Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay.			Environmental Management of the Seto Inlan
WOOD, A. M. Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  Northern Kyushu, Japan.  YASUOKA, Y. Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay.	River Bay and Rehoboth Bay, Delaware.	Northern Kyushu, Japan.	Sea.
Abbeystead Outfall Works: Background to Repairs and Modifications and Lessons Learned.  Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.  Field Survey and Hydraulic Study of 'Aoshio' Tokyo Bay.	W91-10494 2L	W91-10550 5G	W91-103/3
pairs and Modifications and Lessons Learned. Northern Kyushu, Japan. Tokyo Bay.	WOOD, A. M.	YAMADA, M.	
pails and Modifications and Ecosons Seatistics.	Abbeystead Outfall Works: Background to Re-	Northern Kunshu Japan	

#### AUTHOR INDEX

### YAVADA, Y. S.

YAVADA, Y. S.	YONG, R. N.	ZEISS, C.
Impact of Physico-chemical Complexes on	Mechanistic Evaluation of Mitigation of Petrole-	Waste Disposal Facilities and Community Re-
Plankton Density in Dhir Beel of Assam.	um Hydrocarbon Contamination by Soil	sponse: Tracing Pathways from Facility Impacts
W91-11527 2H	Medium.	to Community Attitude.
YE, C.	W91-10779 5G	W91-11280 5E
Pollution and Protection of Bohai Bay.	NOCTED A N	
W91-10522 5B	YOSHIDA, N.	ZELAZNY, L. W.
W91-10322 3B	Finite-Element Analysis of Softening Effects in	Hydrogeochemical Processes Controlling Sub-
YEE, P.	Fissured, Overconsolidated Clays and Mud-	surface Transport from an Upper Subcatchment
1987-89 Drop in Great Lakes Water Levels,	stones.	of Walker Branch Watershed During Storm
Causes and Effect.	W91-10776 8D	Events. 1. Hydrologic Transport Processes.
W91-11023 2H	YOSHIDA, Y.	W91-10907 5E
	Improvement of the Zeta-Plus Filter Method for	W 91-10907
YESERKEPOVA, I. B.	Concentration of Viruses from Water.	Hydrogeochemical Processes Controlling Sub-
Soil Moisture: Empirical Data and Model Re-		surface Transport from an Upper Subcatchment
sults.	W91-10655 5A	
W91-11413 2G	YOUNG, J. S.	of Walker Branch Watershed During Storm
	Confirmatory Chemical Analyses and Solid	Events. 2. Solute Transport Processes.
YICHENG, S.	Phase Bioassays on Sediment from the Columbia	W91-10908 5E
Factors Affecting the Relationship Between the	Piver Petuery et Terror Peint Orec	
NBOD Values and the Amounts of Nitrogenous	River Estuary at Tongue Point, Oregon.	ZELYUKOVA, Y. V.
Pollutants: A Field Study on the Lee River.	W91-10753 5B	Distribution and Migration of Heavy Metals in
W91-10940 5C	Status Report on Remedial Investigation of the	the Environment of the Altai Mountains in Con-
	300 Area Process Ponds.	nection with Ecological Substantiation of the
YIDA, T.	W91-11583 5G	Katun Hydroelectric Station Project.
Factors Affecting the Relationship Between the	W91-11363	W91-11292 5E
NBOD Values and the Amounts of Nitrogenous	YU, J. J.	
Pollutants: A Field Study on the Lee River.	Chromatographic Separation of Arsenic Species	ZENICK, H.
W91-10940 5C	with Sodium Bis(trifluoroethyl)dithiocarbamate	Fertility of Workers Chronically Exposed to
NOTE OF	Chelation.	Chemically Contaminated Sewer Wastes.
YOHE, G. W.	W91-10894 5A	W91-11316 5E
Uncertainty in the Projection of Carbon Dioxide	W71-10074	W91-11310 3L
Emissions. W91-11069 5B	YU, Y.	ZHANG, Q.
W91-11069 5B	Studies on the Situation of Pollution and Coun-	
YOHE, L.	termeasures of Control of the Oceanic Environ-	Simultaneous Ultraviolet Spectrophotometric
Red River Basin Grass Roots Policy Process.	ment in Zhoushan Fishing Ground: The Largest	Determination of Nitrate and Nitrite in Water
W91-11185 6B	Fishing Ground in China.	W91-10824 5A
W 31-11103	W91-10559 5C	
<b>УОКОИСНІ, Н.</b>		ZHONGMIN, Y.
Construction of Artificial Seaweed Bed Accom-	YUASA, I.	Surface Dilution of Round Submerged Buoyan
panied with the Reclamation for Unit No. 3 of	Flow Control Technology for Enhancement and	Jets.
Ikata Power Station.	Diverse Use of the Marine Environment.	W91-10986 5I
W91-10603 2L	W91-10607 2L	
		ZIELINSKI, P.
YOKOYAMA, H.	ZALOM, F. G.	Evaluating Aeration Technology for Radon Re
Succession of Benthic Assemblages in Wild Bird	Effect of Pesticide Treatments on Nontarget Or-	moval.
Park, a Sanctuary Established on Reclaimed	ganisms in California Rice Paddies.	W91-11462 51
Land in Osaka Port.	W91-10835 5C	W 21-11-402 31
W91-10606 2L		ZURBACH, P. E.
	ZAMZOW, M. J.	
YONEZAWA, Y.	Removal of Heavy Metals and Other Cations	Design of Economic and Efficient Treatmen Station for Acidic Streams.
Behavior of Chlorobenzenes in Ise Bay, Estimat-	From Wastewater Using Zeolites.	
ed from Their Concentrations in Various Envi-	W91-11369 5D	W91-11077 50
ronmental Media.		
W91-11325 5B	ZAYDELMAN, F. R.	ZWOLSKI, W.
-	Causes of Degradation of Chemical and Physical	Coal Mine Waters and Their Influence on th
Distribution of Chlorobenzenes in the Bottom	Properties of Chernozems Irrigated with Non-	Purity Ecological State of River and the Fish
Sediments of Ise Bay.	mineralized Water.	Production.
W91-11324 SR	W91-10913 2G	W01.10605

6-13-30 MIHAMAI KARASUYAMA, AGRICULTURAL RESEARCH SERVICE, AKADEMIA ROLNICZA, POZNAN

SEBAGAYA-KU, TOKYO 157, JAPAN.	BOISE, ID. NORTHWEST WATERSHED	(POLAND), DEPT. OF VEGETABLE CROPS.
Runoff Analysis of the Chang Jiang (The	RESEARCH CENTER.  Spatial and Temporal Influence of Soil Frost on	Water Use of a Winter Wheat Cultivar (Triti- cum Aestivum).
Yangtze River). W91-10966 2E	Infiltration and Erosion of Sagebrush Range- lands.	W91-11436 3F
ABERDEEN UNIV. (SCOTLAND). DEPT. OF ENGINEERING.	W91-10820 2G	AKADEMIE DER WISSENSCHAFTEN DER DDR, BERLIN, INST, FUER GEOGRAPHIE
Open Channel Velocity Profiles over a Zone of	AGRICULTURAL RESEARCH SERVICE,	UND GEOOEKOLOGIE.
Rapid Infiltration.	FORT COLLINS, CO.	Rotifers of the Genus Synchaeta-An Important
W91-10984 8B	Water Futures. W91-10506 6B	Component of the Zooplankton in the Coastal Waters of the Southern Baltic.
Changes with Time of the Transport Rate of	AGRICULTURAL RESEARCH SERVICE,	W91-11519 2L
Sediment Mixtures.	TUCSON, AZ.	
W91-10988 7B	RUSLE: Revised Universal Soil Loss Equation.	AKADEMIE DER WISSENSCHAFTEN DER
ABO AKADEMI, TURKU (FINLAND). DEPT. OF BIOLOGY.	W91-10510 2J	DDR, JENA. ZENTRALINSTITUT FUER MIKROBIOLOGIE UND EXPERIMENTELLE THERAPIE.
Introduced SpeciesResource or Threat in	AGRICULTURAL UNIV., WAGENINGEN	Geographical and Pollenanalytical Research of
Brackish-Water Seas: Examples from the Baltic	(NETHERLANDS).  Solution in Closed Form and a Series Solution to	Lake Kleiner Barsch-See (Bez. Potsdam, GDR)
and Black Sea.	Replace the Tables for the Thickness of the	(Geographische und Pollenanalytische Untersu-
W91-10552 2L	Equivalent Layer in Hooghoudt's Drain Spacing	chungen des Kleinen Barsch-Sees) (Bez. Pots-
ABBUACCED ABEATT ACTIVED	Formula.	dam, DDR).
ABWASSER-ABFALL-AQUATECHNIK, DARMSTADT (GERMANY, F.R.).	W91-11430 2G	W91-11514 2H
CHP-Filter PressThe First Continuous High- Pressure Filter Press.	AGRICULTURAL UNIV., WAGENINGEN (NETHERLANDS), DEPT, OF HYDRAULICS	History of Cladocera in the Kleiner Barsch-See, an Acidic, Calcium-Poor, Marshy Pond in the
W91-10702 5D	AND CATCHMENT HYDROLOGY. Regional Approach to Salinity Management in	Middle European Flatland (Die Geschichte der Cladocerenfauna des Kleinen Barsch-Sees, eines
High-Pressure Dewatering with Polymer Condi-	River Basins. A Case Study in Southern Iran.	Sauren, Kalkarmen Moorweihers im Mitteleuro-
tioning as a Prerequisite for the Energy-Inde-	W91-11432 5G	paischen Flachland).
pendent Incineration of Sewage Sludge.	ACDICITE TUDAT TIMES WACENINGEN	W91-11515 2H
W91-11127 5D	AGRICULTURAL UNIV., WAGENINGEN (NETHERLANDS). DEPT. OF WATER	
A CARPENIA CINICA PELINIC (CHINA)	POLLUTION CONTROL.	Analysis of Subfossil Shelled Protozoa in the Sediments of a Small Acid Forest Lake (Kleiner
ACADEMIA SINICA, BEIJING (CHINA). RESEARCH CENTER FOR ECO-	Future Perspectives for the Anaerobic Treat-	Barsch-See, Northern GDR) (Analyse Subfos-
ENVIRONMENTAL SCIENCES.	ment of Forest Industry Wastewaters.	siler Protozoenschalen der Sedimente eines
Pollution and Protection of Bohai Bay.	W91-11478 5D	Kleinen Sauren Waldsees) (Kleiner Barsch-See
W91-10522 5B	Anaerobic Biodegradability and Methanogenic	Nordliche DDR).
	Toxicity of Pulping Wastewaters.	W91-11516 2H
ACADEMIA SINICA, LUOJIASHAN (CHINA).	W91-11480 5D	Diatom Analysis, Late-Glacial and Post-Glacial
INST. OF HYDROBIOLOGY.  Role of Phosphorus Cycling in Algal Metabo-		Development of Lake Kleiner Barsch-Sec
lism and Algal Succession in Lake Donghu, China.	Treatment and Detoxification of Aqueous Spruce Bark Extracts by Aspergillus niger. W91-11481 5D	(GDR)A Preliminary Note. W91-11517 2H
W91-10897 5C	W91-11461 3D	
	Biotechnological Sulphide Removal from Ef-	Chemical Composition of Late- and Post-Glacia
ACADEMY OF NATURAL SCIENCES OF	fluents.	Sediments (Fe, Mn, P, C, N, N, H and BSi) in
PHILADELPHIA, BENEDICT, MD.	W91-11502 5D	Lake Kleiner Barsch-See, a Bog Lake in the North of GDR (Die Chemische Zusammenset
BENEDICT ESTUARINE RESEARCH LAB. Pathways of Silver Uptake and Trophic Trans-	AGRICULTURE CANADA, REGINA	zung der Spat- und Postglazialsedimente de
fer in Estuarine Organisms.	(SASKATCHEWAN), RESEARCH STATION,	Kleinen Barsch-Sees (Fe, Mn, P, C, N, H und
W91-11337 5B	Transformation of (C-14)-2,4-Dichlorophenol in	BSi), eines Dystrophen Moorweihers im Norder
	Saskatchewan Soils.	der DDR).
ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, PA.	W91-10922 5B	W91-11518 2F
Past, Present, and Future of Water Use and	Flow Through Gated Conduits at Partial and	AKADEMIE DER WISSENSCHAFTEN DER
Management. W91-11209 4A	Full Gate Openings. W91-11276 8C	DDR, LEIPZIG. FORSCHUNGSSTELLE FUER CHEMISCHE TOXIKOLOGIE.
AEA TECHNOLOGY, HARWELL (ENGLAND).	AIR FORCE INST. OF TECH., WRIGHT-	Preconcentration of Hydrophilic and Hydropho bic Pesticides from Aqueous Solutions and Ex
ENERGY AND ENVIRONMENT.	PATTERSON AFB, OH. SCHOOL OF CIVIL	traction of Residues Using the Polymeric Sor
Liquid Effluents: New Solutions to Old Prob-	ENGINEERING.	bent Wofatit Y 77.
lems. W91-11360 5D	Analytical Modeling of Aquifer Decontamina- tion by Pumping When Transport is Affected by	W91-11305 5/
	Rate-Limited Sorption. W91-11235 5G	AKADEMIYA NAUK SSSR, MOSCOW. INST.
AGRICULTURAL RESEARCH INST.,	1171-11255	GEOGRAFII.  Aral Sea Basin: A Critical Environmental Zone
NICOSIA (CYPRUS).	AIR PRODUCTS AND CHEMICALS, INC.,	W91-11441 60
Trickle Irrigation of Sunflower With Municipal Wastewater.	TREXLERTOWN, PA.	W 21-11-4-1
W91-11435 3F	an industrial Efficiency Amoient Temperature	
AGRICULTURAL RESEARCH SERVICE,	Purge and Trap Capillary GC-MS and by Heated Purge and Trap GC-FID.	Dynamic-Stochastic Models of Rainfall an
BELTSVILLE, MD. HYDROLOGY LAB.	W91-11336 5A	Snowmelt Runoff Formation.
Water Supply Implication of Climate Change in		W91-10967
Western North American Basins.	AKADEMIA ROLNICZA, LUBLIN (POLAND).	AKADEMIYA NAUK SSSR, NOVOSIBIRSK.
W91-11059 2B		INST. OF SOIL SCIENCE AND
Relationship of MSS and TM Digital Data with	HYDROBIOLOGY.  Coal Mine Waters and Their Influence on the	
Suspended Sediments, Chlorophyll, and Tem-		
perature in Moon Lake, Mississippi.	Production.	Soils.
W91-11354 7C		W91-10916 20
		OR-1

#### AVEON HAIV OH DERT OF CIVIL ENGINEERING

AKRON UNIV., OH. DEPT. OF CIVIL ENGINEERING. Analysis of Large Scale Water Distribution Sys-	AMERICAN WATER RESOURCES ASSOCIATION, BETHESDA, MD. Past, Present, and Future of Water Resources	ARIZONA UNIV., TUCSON, DEPT. OF SOIL AND WATER SCIENCE.  Application of a Multiprocess Nonequilibrium
tems. W91-10983 5F	Management In the United States. W91-11207 4A	Sorption Model to Solute Transport in a Strati- fied Porous Medium.
ALASKA DEPT. OF FISH AND GAME,	AMERICAN WATER WORKS SERVICE OF	W91-11239 5B
SOLDOTNA. FISHERIES REHABILITATION,	AMERICAN WATER WORKS SERVICE CO., VOORHEES, NJ.	
ENHANCEMENT AND DEVELOPMENT DIV. Secchi Disk and Photometer Estimates of Light	Evaluating Aeration Technology for Radon Re-	ARIZONA UNIV., TUCSON. OFFICE OF
Regimes in Alaskan Lakes: Effects of Yellow	moval.	ARID LANDS STUDIES.  Residential Water Conservation: Casa Del Agua.
Color and Turbidity.	W91-11462 5F	W91-10814 3D
W91-10860 2H	AMSTERDAM UNIV. (NETHERLANDS), LAB.	W71-10014
ALASKA UNIV., FAIRBANKS. SCHOOL OF	FOR PHYSICAL GEOGRAPHY AND SOIL	ARKANSAS UNIV., FAYETTEVILLE.
ENGINEERING.	SCIENCE.	Tree-Ring Reconstructed Sunshine Duration
Ambient Air Co-Modeling in Alaska.	Microwave Transmission, a New Tool in Forest Hydrological Research.	over Central USA.
W91-11070 7C	W91-10995 21	W91-10972 2I
ALBERTA UNIV., EDMONTON. DEPT. OF		ARKANSAS UNIV. FOR MEDICAL
CIVIL ENGINEERING.	AMSTERDAM UNIV. (NETHERLANDS), LAB, VOOR MICROBIOLOGIE.	SCIENCES, LITTLE ROCK, COLL. OF
Finite-Element Analysis of Softening Effects in Fissured, Overconsolidated Clays and Mud-	Microcystis Changes its Buoyancy in Response	PHARMACY.
stones.	to the Average Irradiance in the Surface Mixed	Characterization of Radioactivity in Hot Springs
W91-10776 8D	Layer.	National Park, Arkansas.
Anaerobic Treatability of a Phenolic Coal Con-	W91-10895 2H	W91-10846 2K
version Wastewater After Diisopropyl Ether	ANJOU RECHERCHE, MAISONS-LAFFITTE	ARKANSAS UNIV., LITTLE ROCK, DEPT. OF
Extraction.	(FRANCE), LAB, D'HYGIENE ET	ELECTRONICS AND INSTRUMENTATION.
W91-10939 5D	RECHERCHE EN SANTE PUBLIQUE.	Comparison of Pressurized and Gravity Distri-
Hydraulics of Culvert Fishways IV: Spoiler	Efficiency of an Ozoflotation-Filtration Process for the Treatment of the River Thames at	bution Systems for Wastewater Treatment.
Baffle Culvert Fishways.	Walton Works.	W91-10845 5D
W91-11279 8I	W91-11268 5F	A DAME TO CONTENT AND THE PROPERTY AND
Waste Disposal Facilities and Community Re-	ADDITED CROTHING TER DECEARCH	ARMY ENGINEER WATERWAYS EXPERIMENT STATION, SPRING VALLEY,
sponse: Tracing Pathways from Facility Impacts	APPLIED GROUNDWATER RESEARCH LTD., MISSISSAUGA (ONTARIO).	WI. EAU GALLE LAB.
to Community Attitude. W91-11280 5E	Method for Assessing Residual NAPL Based on	Estimation of Phosphorus Exchange Between
77111200	Organic Chemical Concentrations in Soil Sam-	Littoral and Pelagic Zones During Nighttime
ALEXANDRIA UNIV. (EGYPT), DEPT. OF	ples. W91-10797 5A	Convective Circulation.
OCEANOGRAPHY.  Patella vulgata, Mytilus minimus and Hyale pre-	W91-10797 5A	W91-10863 2H
vosti as Bioindicators for Pb and Se Enrichment	APPLIED RESEARCH CORP., LANDOVER,	ARMY ENGINEER WATERWAYS
in Alexandria Coastal Waters.	MD.	EXPERIMENT STATION, VICKSBURG, MS.
W91-10875 5A	Comparison of Microwave Techniques for Measuring Rainfall.	HYDRAULICS LAB.
ALEXANDRIA UNIV. (EGYPT). DEPT. OF	W91-10499 2B	Melvin Price Locks and Dam Auxiliary Lock
SOIL AND WATER SERVICES.		and Rotary Lock Culvert Valve, Mississipp River, Alton, Illinois: Hydraulic Model Investi-
Lead Sorption in Calcareous Soils. W91-11453 5B	ARGONNE NATIONAL LAB., IL.	gation.
	CHEMISTRY DIV.  Application of Supported Liquid Membranes for	W91-10723 8C
ALEXANDRIA UNIV. (EGYPT). INST. OF GRADUATE STUDIES AND RESEARCH.	Removal of Uranium From Groundwater.	
Chemical Composition of the Interstitial Water	W91-11370 5G	St. Johns Bayou Pumping Station, Missouri: Hy
in Bottom Sediments of Tyrrhenian Sea (West-	Synthesis and Decomposition of Novel Organo-	draulic Model Investigation. W91-11588 80
ern Mediterranean): Diagenetic Processes. W91-10880	phosphorus Complexants.	W 91-11386
W91-10880	W91-11372 5D	ARMY ENVIRONMENTAL HYGIENE
ALIGARH MUSLIM UNIV. (INDIA).		AGENCY, ABERDEEN PROVING GROUND,
CHEMISTRY SECTION.  Spectrophotometric Determination of Nitrite in	ARGONNE NATIONAL LAB., IL. ENVIRONMENTAL RESEARCH DIV.	MD. ORGANIC ENVIRONMENTAL
Polluted Waters Using 3-Nitroaniline.	Comparison of Nocturnal Drainage Flow in	CHEMISTRY DIV.  Determination of Nitroaromatics and Nitramine
W91-10823 5A	Three Tributaries.	in Ground and Drinking Water by Wide-Born
ALIGARH MUSLIM UNIV. (INDIA), DEPT.	W91-10501 2E	Capillary Gas Chromatography.
OF APPLIED CHEMISTRY.	Great Lakes Total Phosphorus Model: Post	W91-11262 5A
Studies on the Effects of Some Organic Pollut-	Audit and Regionalized Sensitivity Analysis.	
ants on the Heavy Metal Transport in an Indian	W91-10974 2H	ASIAN INST. OF TECH., BANGKOK
Soil. W91-11457 5C	ARIZONA UNIV., TUCSON, DEPT. OF CIVIL	(THAILAND), DIV. OF ENVIRONMENTAL ENGINEERING.
	ENGINEERING.	Use of a Backflush Technique in Cross-flow
ALL-UNION SCIENTIFIC RESEARCH INST. OF IRRIGATED AGRICULTURE,	Biological Dehalogenation of Kraft Mill	Microfiltration for Treating Natural Water and
VOLGOGRAD (USSR).	Wastewaters.	Filter Backwash Wastewater in Water Works
Effect of Long-Term Application of Fertilizers	W91-11497 5D	W91-11270 51
on the Agrophysical Properties of an Irrigated	ARIZONA UNIV., TUCSON, DEPT. OF CIVIL	ATMOSPHERIC ENVIRONMENT SERVICE,
Light-Chestnut Soil. W91-10914 2G	ENGINEERING AND ENGINEERING	DOWNSVIEW (ONTARIO).
	MECHANICS.	Relationship Between Mean and Standard Devi
AMBIOTEK, INVESTIGACION CIENTIFICA Y	Permeability of Soils with Organic Fluids. W91-10783 5B	ation in Precipitation Chemistry Measurement
TECNICA DEL MEDIO AMBIENTE MENDI ALDE, NO. 13 IOB, ORTUELLA (BIZTRAIA),		Across Eastern North America.
SPAIN.	ARIZONA UNIV., TUCSON, DEPT. OF	W91-10475
Morphology and Quantitative Analysis of Fluvi-	MICROBIOLOGY AND IMMUNOLOGY.	Canadian Atlantic Storms Program: Progres
al Erosion Systems in the Hydrological Network of the Basque Country Autonomous Region.	Detection of Rotaviruses in Water by Gene Probes.	and Plans of the Meteorological Componen
W91-11265 2J	W91-10668 5A	

#### BRITISH COLUMBIA UNIV., VANCOUVER. DEPT. OF ANIMAL SCIENCE.

AUBURN UNIV., AL. DEPT. OF CIVIL ENGINEERING.	BAYER A.G., LEVERKUSEN (GERMANY, F.R.).	Direct Aqueous Injection-Liquid Chromatogra- phy With Post-Column Derivatization for De-
Impact of Recharge Through Residual Oil Upon	Acute Aquatic Toxicity of Alkyl Phenol Ethox-	termination of N-Methylcarbamoyloximes and
Sampling of Underlying Ground Water.	ylates.	N-Methylcarbamates in Finished Drinking
W91-10793 5B	W91-10833 5C	Water: Collaborative Study.
		W91-11260 5A
AZABU UNIV., SAGAMIHARA (JAPAN).	BAYERISCHE LANDESANSTALT FUER	
DEPT. OF ENVIRONMENTAL	BODENKULTUR UND PFLANZENBAU,	BIOTECHNOLOGY RESEARCH INST.,
TECHNOLOGY.	MUNICH (GERMANY, F.R.).	MONTREAL (QUEBEC).
Clostridium perfringens, as an Indicator Micro- organism for the Evaluation of the Effect of	Studies for a Simultaneous Use of Liquid	Modeling the Upflow Anaerobic Sludge Bed-
Wastewater and Sludge Treatment Systems.	Manure and Sewage Sludge.	Filter System: a Case with Hysteresis.
W91-10686 5D	W91-11157 5E	W91-11321 5D
		BURNING AND
BABTIE DOBBI, CONSULTING ENGINEERS,	BAYERISCHE LANDESANSTALT FUER WASSERFORSCHUNG, MUNICH (GERMANY,	BIRMINGHAM UNIV. (ENGLAND), DEPT. OF GEOGRAPHY.
CROYDON, SURREY, ENGLAND.	F.R.).	Climatic Change and Future Agroclimatic Po-
Fenay Beck Flood-Alleviation Scheme.	UV Disinfection of Secondary Effluents from	tential in Europe.
W91-11365 8A	Sewage Treatment Plants.	W91-10970 2B
BATTER OF THE STATE OF	W91-10681 5D	117110710
BAHRAIN UNIV., MANAMA. DEPT. OF		BOLOGNA UNIV. (ITALY). IST. DI
BIOLOGY. Polyvalent Coliphages in Sewage.	BAYREUTH UNIV. (GERMANY, F.R.), CHAIR	BIOCHIMICA.
W91-10663 5A	OF ECOLOGICAL CHEMISTRY AND	Seasonal Variations of Aliphatic Hydrocarbons
***************************************	GEOCHEMISTRY.	in Sardina pilchardus (Walb.) (Teleostei: Clupei-
BARCELONA UNIV. (SPAIN), DEPT, DE	Determination of Effective Diffusion Coeffi-	dae) Tissues.
ECOLOGIA.	cients for Gaseous and Dissolved Organic Sub-	W91-10839 5B
Hydrological Balance of Two Mediterranean	stances in Soil Material Using a 'Stopped Elu-	
Forested Catchments (Prades, Northeast Spain).	tion' Method with HPLC and GC.	BONN UNIV. (GERMANY, F.R.). HYGIENE
W91-10963 2A	W91-10802 7B	INST.
		Growth and Inactivation Kinetics of Mycobac-
BARCELONA UNIV. (SPAIN). DEPT. OF	BCM ENGINEERS, INC., PLYMOUTH	teria in Biofilms. W91-10642 5B
MICROBIOLOGY.	MEETING, PA.	W91-10042 5B
Concentration of Hepatitis A Virus in Environ-	New Storm Water Regulations Require Signifi- cant Compliance Actions by Both Industries and	BORDEAUX-1 UNIV., TALENCE (FRANCE).
mental Samples. W91-10658 5A	Municipalities.	LAB. DE PHOTOPHYSIQUE ET
W91-10038 3A	W91-11541 5D	PHOTOCHIMIE MOLECULAIRE.
BARRY UNIV., MIAMI SHORES, FL. DIV. OF	W31-11341	Organotin Stability During Storage of Marine
BIOLOGICAL AND BIOMEDICAL SCIENCES.	BEDFORD INST. OF OCEANOGRAPHY.	Waters and Sediments.
Effects of Acid Rain on Epiphytic Orchid	DARTMOUTH (NOVA SCOTIA).	W91-11255 5A
Growth.	BIOLOGICAL OCEANOGRAPHY DIV.	
W91-11076 5C	Coulometric Measurement of Primary Produc-	BRADFORD UNIV. (ENGLAND). DEPT. OF
	tion, with Comparison against Dissolved	CIVIL ENGINEERING AND STRUCTURAL
BASF A.G., LUDWIGSHAFEN AM RHEIN	Oxygen and 14-C Methods in a Seasonal Study.	ENGINEERING.
(GERMANY, F.R.).	W91-10868 2L	Seasonal Influences on the Sediment Transport
Sewage Sludge Incineration and Utilization of		Characteristics of the Sacramento River, Cali-
Energy.	BEIJING UNIV. (CHINA). DEPT. OF	fornia.
W91-11131 5D	GEOGRAPHY.	W91-10847 2J
BASRAH UNIV. (IRAQ). DEPT. OF BIOLOGY.	Factors Affecting the Relationship Between the	Three-Dimensional Numerical Modelling of
Bacteriological Suitability of Water from Basrah	NBOD Values and the Amounts of Nitrogenous Pollutants: A Field Study on the Lee River.	Wind-Driven Circulation in a Shallow Homoge-
Wells for Drinking.	W91-10940 5C	neous Lake.
W91-10629 5A	W 91-109-40	W91-10992 2H
	BEN-GURION UNIV. OF THE NEGEV, SDE	
BATH UNIV. (ENGLAND). SCHOOL OF	BOKER (ISRAEL), JACOB BLAUSTEIN INST.	BRIGHTON POLYTECHNIC (ENGLAND).
BIOLOGICAL SCIENCES.	FOR DESERT RESEARCH.	DEPT. OF CIVIL ENGINEERING.
Sewage Treatment with Plants.	Denitrification in Laboratory Sand Columns:	Gammarus: Asellus Ratio as an Index of Organic
W91-11466 5D	Carbon Regime, Gas Accumulation and Hy-	Pollution.
BATTELLE PACIFIC NORTHWEST LABS.,	draulic Properties.	W91-11331 5A
RICHLAND, WA.	W91-11330 5G	
Installation of the Westbay Multiport Ground-		BRITISH COLUMBIA MINISTRY OF
Water Sampling System in Well 699-43-42K	BERGEN UNIV. (NORWAY). DEPT. OF	ENVIRONMENT, VICTORIA. ENVIRONMENTAL PROTECTION DIV.
Near The 216-B-3 Pond.	BIOCHEMISTRY.	Effects of Suspended Sediments on Aquatic
W91-10720 7B	Immunochemical Detection of Cytochrome	Ecosystems.
	P450IA1 Induction in Cod Larvae and Juveniles Exposed to a Water Soluble Fraction of North	W91-11426 5C
Relationship of Regional Water Quality to Aqui-	Sea Crude Oil.	W 91-11420
fer Thermal Energy Storage.	W91-10871 5A	BRITISH COLUMBIA MINISTRY OF
W91-11082 5C		ENVIRONMENT, VICTORIA. WASTE
Detirontion of Court Fish Howard for Bish and	BIGELOW LAB. FOR OCEAN SCIENCES,	MANAGEMENT BRANCH.
Estimation of Sport Fish Harvest for Risk and Hazard Assessment of Environmental Contami-	WEST BOOTHBAY HARBOR, ME.	Chemical Composition of Individual Storms as a
nants.	Annual Bacterial Production in Relation to	Function of Air Parcel Trajectories for the Pre-
W91-11556 5G	Benthic Microalgal Production and Sediment	diction of Acid Rain Characteristics.
	Oxygen Uptake in an intertidal Sandflat and an	W91-11075 5B
Status Report on Remedial Investigation of the	Intertidal Mudflat.	ACTUACION A DIVIGIO A A COMPANIA COMPAN
300 Area Process Ponds.	W91-10865 2L	ATLAS*GRAPHICS: An Affordable Mapping
W91-11583 5G	DIONITHOS GODD CHICKENIATI OIL	System. W91-11175 7C
	BIONETICS CORP., CINCINNATI, OH.	W71-111/3
BATTELLE PACIFIC NORTHWEST LABS.,	Capillary Column Gas Chromatography With Nitrogen-Phosphorus Detection for Determina-	BRITISH COLUMBIA UNIV., VANCOUVER.
SEQUIM, WA. MARINE RESEARCH LAB.	tion of Nitrogen-and Phosphorus-Containing	DEPT. OF ANIMAL SCIENCE.
Confirmatory Chemical Analyses and Solid Phase Bioassays on Sediment from the Columbia	Pesticides in Finished Drinking Waters: Collabo-	Dioxin Contamination and Growth and Devel-
River Estuary at Tongue Point, Oregon.	rative Study.	opment in Great Blue Heron Embryos.
W91-10753 5B		W91-10837 5C

#### BRITISH COLUMBIA UNIV., VANCOUVER. DEPT. OF CIVIL ENGINEERING.

PRINCIPLE COLUMN TO THE MANAGEMENT	TO THE RESERVE AND ADDRESS OF THE PARTY OF T	CATTERNAL TRAIL DAVIS DIV OF
BRITISH COLUMBIA UNIV., VANCOUVER. DEPT. OF CIVIL ENGINEERING. Comparison of Field Consolidation with Labora-	Effects of Land Use Alteration on Tropical Carbon Exchange. W91-11072 4C	CALIFORNIA UNIV., DAVIS. DIV. OF ENVIRONMENTAL STUDIES. Increased Precipitation Acidity in the Central
tory and In Situ Tests.		Sierra Nevada.
W91-10781 8D	CADI AYYAD UNIV., MARRAKECH (MOROCCO). LAB. DE MICROBIOLOGIE.	W91-10471 5B
Deep-Seated Consolidation Settlements in the Fraser River Delta.	Dynamics of Non-01 Vibrio cholerae in Experi- mental Sewage Stabilization Ponds Under Arid	Zooplankton Effects on Phytoplankton in Lakes
W91-10948 8D	Mediterranean Climate. W91-10690 5D	of Contrasting Trophic Status. W91-10859 2H
BRITISH COLUMBIA UNIV., VANCOUVER.		
DEPT. OF GEOGRAPHY.  Distance of Movement of Coarse Particles in	Aeromonas Species Stabilization Ponds in the Arid Region of Marrakesh, Morocco, and Rela-	CALIFORNIA UNIV., LOS ANGELES, DEPT. OF ATMOSPHERIC SCIENCES.
Gravel Bed Streams. W91-11231 2J	tion to Fecal-Pollution and Climatic Factors. W91-10842 5D	Kinematic, Dynamic, and Thermodynamic Analysis of a Weakly Sheared Severe Thunder-
BRITISH GEOLOGICAL SURVEY,	CAIRO UNIV., GIZA (EGYPT). FACULTY OF	storm over Northern Alabama. W91-11417 2B
WALLINGFORD (ENGLAND), Discrete-Kernel Method for Simulating Pump-	AGRICULTURE. Effect of Low Salinity Water on Salt Displace-	
ing Tests in Large-Diameter Wells. W91-10998 2F	ment in Two Soils. W91-11433 2G	CALIFORNIA UNIV., PARLIER. MOSQUITO CONTROL RESEARCH LAB.
BRNO UNIV. (CZECHOSLOVAKIA). DEPT.	CALABAR UNIV. (NIGERIA). INST. OF	Studies on the Environmental Persistence of S- 31183 (Pyriproxyfen): Adsorption onto Organic
OF BIOLOGY.	OCEANOGRAPHY.	Matter and Potential for Leaching through Soil.
Microzoobenthos of the River Jihlava After the Construction of the Dalesice Waterworks.	Tar Balls on Ibeno-Okposo Beach of South-East Nigeria.	W91-10831 5B
W91-11521 6G	W91-10876 5B	CALIFORNIA UNIV., RIVERSIDE, DEPT. OF
BROCK UNIV., ST. CATHARINES	CALIFORNIA DEPT. OF HEALTH SERVICES.	SOIL AND ENVIRONMENTAL SCIENCES.
(ONTARIO), DEPT. OF ECONOMICS.  Costs and Benefits of Moving to Peak-Load	BERKELEY. HAZARDOUS MATERIALS LAB. SECTION.	Production Functions Relating Crop Yield, Water Quality and Quantity, Soil Salintiy and
Pricing for Municipally-Supplied Water. W91-11047 6C	Determination of Chlorinated Phenoxy Acid and Ester Herbicides in Soil and Water by	Drainage Volume. W91-11434 3C
	Liquid Chromatography Particle Beam Mass Spectrometry and Ultraviolet Absorption Spec-	
BROOKHAVEN NATIONAL LAB., UPTON, NY. DEPT. OF APPLIED SCIENCE.	trophotometry.	CALIFORNIA UNIV., RIVERSIDE. INST. OF GEOPHYSICS AND PLANETARY PHYSICS.
Role of Biotechnology in the Treatment of Geo- thermal Residual Sludges.	W91-10893 5A	Delineation of a Discontinuous Aquitard with Vertical Electrical Soundings, San Bernardino
W91-10744 5D	CALIFORNIA INST. OF TECH., PASADENA.  Nonlinear Earthquake Response of Concrete	Valley, Southern California.
BROWN AND CALDWELL, PLEASANT HILL,	Gravity Dam Systems.	W91-10960 5B
CA.	W91-10754 8F	CALIFORNIA UNIV., SANTA BARBARA.
Water Use Reductions from Retrofitting Indoor	CALIFORNIA STATE COASTAL	CENTER FOR REMOTE SENSING AND
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6D

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5B

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W91-11414 2B		W91-11309 5A
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Superfund Record of Decision: Reich Farms,	From Sludge Technology. W91-11133 5D	rameters used in Thunderstorm Forecasting. W91-11423 2B
NJ.	ENVIRONMENTAL PROTECTION SERVICE,	W71-11423 2D
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W91-11582 5G	Application of a Hazard Assessment Research Strategy to the Ocean Disposal of a Dredge	
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National Estuary Program and Public Involve- ment.	Hazard Assessment Research Strategy for Ocean Disposal.	<ul> <li>Coated with Metallic Oxides and Metallic Per- oxides.</li> </ul>
W91-10590 5G	W91-11551 51	

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Florida's Pesticide Water Quality Education Program.	Impact of Physico-chemical Complexes on Plankton Density in Dhir Beel of Assam.	Basin in Central Nevada, U.S.A. W91-11392 2K
W91-11202 5G	W91-11527 2H	
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FOREST RESEARCH INST., ROTORUA (NEW	GENERAL MOTORS RESEARCH LABS.,	Thermal-Pulse Flowmeter for Measuring Slow
ZEALAND).  Effects of Chlorination Conditions On the AOX and Chlorinated Phenol Content of Kraft Bleach	WARREN, MI. ENVIRONMENTAL SCIENCE DEPT. Aqueous Surfactant Washing of Residual Oil	Water Velocities in Boreholes. W91-10766 8G
Plant Wastewaters. W91-11474 5D	Contamination from Sandy Soil. W91-10796 5G	Hydrogeologic Inferences from Drillers' Logs and from Gravity and Resistivity Surveys in the
FOREST RESEARCH INST., ROTORUA (NEW ZEALAND), WOOD TECHNOLOGY DIV. Development of Environmental Control Legis-	GEOLOGICAL SURVEY, ALBANY, NY. WATER RESOURCES DIV. Availability of Ground Water from Unconsoli-	Amargosa Desert, Southern Nevada. W91-10996 5E
lation and Effluent Standards for Australasian Wood Processing Industries. W91-11472 5G	dated Deposits in the Mohawk River Basin, New York. W91-11104 2F	Graphical Method for Determining the Coeffi- cient of Consolidation cv from a Flow-Pump Permeability Test.
	Hydrogeology of the Valley-Fill Aquifer at	W91-11393 7C
FOREST SERVICE, GLENWOOD, AR. Aquatic Macroinvertebrates of the St. Francis Sunken Lands in Northeast Arkansas.	Owego, Tioga County, New York. W91-11105 2F	Paleohydrologic Techniques Used to Define the Spatial Occurrence of Floods.
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FORSCHUNGSINSTITUT FUER MIKROBIOLOGIE UND HYGIENE, BAD ELSTER (GERMAN D.R.). Study of Campylobacter in Sewage, Sewage Sludge and in River Water.	NM. WATER RESOURCES DIV. Geohydrology and Simulation of Ground-Water Flow in the Mesilla Basin, Dona Ana County, New Mexico, and El Paso County, Texas. W91-11088 2F	Analysis and Interpretation of the Borehole Televiewer Log: Information on the State of Stress and the Lithostratigraphy at Hole 504B. W91-11549
W91-10634 5D	GEOLOGICAL SURVEY, ARVADA, CO.	GEOLOGICAL SURVEY, DENVER, CO.
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LAB. Humic Substances in Acid Surface Waters;	lina.	W91-11103 5B
Modelling Aluminium Binding, Contribution to Ionic Charge-Balance, and Control of pH. W91-10933 5C	W91-11598 2F GEOLOGICAL SURVEY, AUSTIN, TX.	Simulation of Precipitation by Weather Type Analysis.
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BAYSVILLE, ONTARIO POB 1A0.  Phosphorus from Internal Sources in the Laurentian Great Lakes, and the Concept of Threshold External Load.  W91-10982  5B	W91-11593 5B  GEOLOGICAL SURVEY, BATON ROUGE, LA. WATER RESOURCES DIV. Maps of the '400-foot,' 600-foot,' and Adjacent Aquifers and Confining Beds, Baton Rouge	GEOLOGICAL SURVEY, DORAVILLE, GA. Update of Flood-Flow Characteristics of Nancy Creek at Georgia Highway 400 Extension Near Atlanta, Georgia. W91-10762 2E
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and Stabilizing Sludge. W91-11143 5D	Chicot Aquifer System of Southwestern Louisi-	GEOLOGICAL SURVEY, DORAVILLE, GA.
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7C

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Assessing the Response of Emerald Lake, an Alpine Watershed in Sequoia National Park, California, to Acidification during Snowmelt by Using a Simple Hydrochemical Model.  W91-11594  5C	GEOLOGICAL SURVEY, RESTON, VA. Report of the River Master of the Delaware River, for the Period December 1, 1988-Novem- ber 30, 1989. W91-10765 4A	GEOLOGICAL SURVEY, SACRAMENTO, CA. WATER RESOURCES DIV. Calibration of a Texture-Based Model of a Ground-Water Flow System, Western San Joa-
W91-11594 5C	***************************************	quin Valley, California. W91-11101 5B
GEOLOGICAL SURVEY, HARTFORD, CT. WATER RESOURCES DIV.	Effects of Changes in Land Use on Annual Streamflows in the Lake Huron Basin of Canada and the United States.	GEOLOGICAL SURVEY, SAN DIEGO, CA.
Application of Ground-Penetrating-Radar Meth- ods in Hydrogeologic Studies.	W91-11021 4C	Use of a Single-Bowl Continuous-Flow Centri- fuge for Dewatering Suspended Sediments:
W91-10956 7B	Planned Studies of Agrichemicals in Ground	Effect on Sediment Physical and Chemical
GEOLOGICAL SURVEY, IOWA CITY, IA.	and Surface Water in the Mid-Continental	Characteristics.
Statistical Summaries of Selected Iowa Stream- flow Data Through September 30, 1988.	United States. W91-11168 5B	W91-11350 7B
W91-10770 2E	Dendrogeomorphic Approach to Estimating	GEOLOGICAL SURVEY, ST. PAUL, MN.  Monthly Mean Discharge at and Between Se-
GEOLOGICAL SURVEY, IOWA CITY, IA. WATER RESOURCES DIV.	Slope Retreat, Maxey Flats, Kentucky. W91-11395 2D	lected Streamflow-Gaging Stations Along the Mississippi, Minnesota, and St. Croix Rivers,
Automatic Tracer-Dilution Method Used for	Dendrogeomorphic Approach to Measurement	1932-87.
Stage-Discharge Ratings and Streamflow Hy- drographs on Small Iowa Streams.	of Sedimentation in a Forested Wetland, Black Swamp, Arkansas.	W91-10760 2E
W91-11111 7B	W91-11397 2H	GEOLOGICAL SURVEY, TACOMA, WA.  Variability of Glacier Mass Balances in Western
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WATER RESOURCES DIV.  Evaluation of Three Scenarios of Ground-Water	W91-11438 2K	W91-11391 2C
Withdrawal from the Mississippi River Alluvial	Estimating Flow Characteristics at Ungauged	Application of Uphole Data from Petroleum
Aquifer in Northwestern Mississippi. W91-11106 4B	Sites. W91-11545 2E	Seismic Surveys to Groundwater Investigations, Abu Dhabi (United Arab Emirates).
Channel and Bank Stability of Wolf Creek and a	GEOLOGICAL SURVEY, RESTON, VA.	W91-11399 7C
Tributary at U.S. Highway 45 Near Wheeler,	WATER RESOURCES DIV. Fast Algorithm for Automatically Computing	GEOLOGICAL SURVEY, TACOMA, WA.
Prentiss County, Mississippi.	Strahler Stream Order.	WATER RESOURCES DIV.
W91-11107 2E	W91-10818 2J	Characterization and Simulation of Rainfall-
GEOLOGICAL SURVEY, LAKEWOOD, CO.	U.S. Geological Survey Federal-State Coopera-	Runoff Relations for Headwater Basins in West- ern King and Snohomish Counties, Washington.
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Techniques for Estimation of Storm-Runoff Loads, Volumes, and Selected Constituent Con-	W91-11109 7B	
centrations in Urban Watersheds in the United	Methodology to Derive Water-Quality Trends	GEOLOGICAL SURVEY, TALLAHASSEE, FL. WATER RESOURCES DIV.
States. W91-11094 5B	for Use by the National Water Summary Pro-	Assessment of Hydrogeologic Conditions with
GEOLOGICAL SURVEY, LANSING, MI.	gram of the U.S. Geological Survey. W91-11110 7B	Emphasis on Water Quality and Wastewater In- jection, Southwest Sarasota and West Charlotte
WATER RESOURCES DIV.	Magnetite Formation During Microbial Dissimi-	Counties, Florida.
Geohydrology and Water Quality of Kalamazoo County, Michigan, 1986-88.	latory Iron Reduction. W91-11544 2J	W91-11087 2F
W91-11091 2F	Directory of Member Organizations of the National Water Data Exchange (NAWDEX).	Analysis of Ground-Water Flow in the A-Sand Aquifer at Paramaribo, Suriname, South Amer-
GEOLOGICAL SURVEY OF CANADA, OTTAWA (ONTARIO).	W91-11574 10D	ica. W91-11090 2F
Engineering Geology of Nearshore Areas off	Directory of Assistance Centers of the National	
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W91-10944 2J	CHOLOGICAL GURNERY ROLLA MO	Partial Correlations of Land Use and Shallow Ground-Water Quality.
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OTTAWA (ONTARIO). TERRAIN SCIENCES	Delineation of Flooding within the Ozark Na-	
DIV.  Analysis of Ground-Probing Radar Data: Pre-	tional Scenic Riverways in Southeastern Missou- riAkers and Alley Spring.	GEOLOGICAL SURVEY, TUCSON, AZ.
dictive Deconvolution.	W91-11578 2E	Flood-Hazard Zonation in Arid Lands. W91-11390 6F
W91-10782 8G	Delineation of Flooding within the Occal No.	
GEOLOGICAL SURVEY, OKLAHOMA CITY, OK.	Delineation of Flooding within the Ozark Na- tional Scenic Riverways in Southeastern Missou- riRound Spring and Powder Mill.	GEOLOGICAL SURVEY, WEST TRENTON, NJ.
Hydrology of the Arbuckle Mountains Area, South-Central Oklahoma.	W91-11579 2E	Simulated Hydrologic Effects of Climatic Change in the Delaware River Basin.
W91-11590 2F	Analysis of Alternative Modifications for Reducing Backwater Flooding at the Honey Creek	W91-11060 5C
GEOLOGICAL SURVEY, PORTLAND, OR. WATER RESOURCES DIV.	Coal Strip Mine Reclamation Site in Henry County, Missouri.	Geophysical and Chemical Investigations of Ground Water at Five Industrial or Waste-Dis-
Geologic Framework of the Columbia Plateau	W91-11595 2E	posal Sites in Logan Township, Gloucester County, New Jersey, 1983-87.
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GEOLOGICAL SURVEY, PROVIDENCE, RI. WATER RESOURCES DIV.	California. I. Geochemical Assessment. W91-10768 5B	WASHINGTON, DC. DEPT. OF CIVIL, MECHANICAL, AND ENVIRONMENTAL
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Island. W91-11572 2F	ment. W91-10769 5B	

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W91-11240 2F	Sheep-Dips as a Source of Pollution of Freshwaters: A Study in Grampian Region.	sions, Problems and Potential. W91-10730 5G
GIESSEN UNIV. (GERMANY, F.R.), INST.	W91-11356 5B	
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tudes During the Past 20 m. y.	Great Lakes Regional Water Use Data Reposi-	W91-10693 5E
W91-10791 2J	tory. W91-11010 6D	
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Clouds.	GREELEY AND HANSEN, CHICAGO, IL.	of Nitrification and Denitrification.
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CUCC BORCON NICOTERWAY	W91-11223 5D	HEIDELBERG UNIV. (GERMANY, F.R.).
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Pollutant Transport Monitoring and Prediction	W91-11146 5D	to Dinitro-o-cresol: An Ultrastructural and Bio- chemical Study.
by Mathematical Modelling: North Sea and Ad- jacent Estuaries.	GUELPH UNIV. (ONTARIO), DEPT. OF	W91-10826 5C
W91-10600 5B	AGRICULTURAL ECONOMICS AND	
	BUSINESS,	HELSINKI UNIV. (FINLAND), DEPT. OF
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fluents and Winning Valuable Products by Suc-	W91-11050 3F	Fungi Grown on Bleach Plant Effluents.
cessive Flocculation and Microbial Growth.		W91-11487 5D
W91-11488 5D	Social and Private Returns from Wetland Pres- ervation.	
GOETTINGEN UNIV. (GERMANY, F.R.).	W91-11057 5G	HELSINKI UNIV. OF TECHNOLOGY, ESPOO (FINLAND).
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W91-10878 2I	GUELPH UNIV. (ONTARIO). DEPT. OF	HERIOT-WATT UNIV., EDINBURGH (SCOTLAND), DEPT. OF CIVIL
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What Stakeholders Want and Why.	water Stream.	uted Catchment Models.
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W91-10968 2A	W91-11033 6B	Environmental Protection. W91-10588 5G
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sults.	PARK, NJ. RESEARCH AND DEVELOPMENT	HIROSHIMA PREFECTURAL RESEARCH
W91-11413 2G		CENTER FOR ENVIRONMENTAL SCIENCE
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(NETHERLANDS).		W/1-10330
Dutch Approach to Manure Processing.	HALCROW (WILLIAM) AND PARTNERS,	HOHENHEIM UNIV., STUTTGART
W91-10703 5D	SWINDON (ENGLAND), Simulation of Bioecological and Water Quality	(GERMANY, F.R.). INST. FUER
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HOSHANGABAD (INDIA), DEPT, OF	W91-10557 5C	Microbiological Aspects.
ZOOLOGY.	THAT THE CHANGE OF THE PARTY OF	W91-11125 5D
Seasonal Variations and Relationships of Differ- ent Physico-chemical Characteristics in Newly		
Made Tawa Reservoir.	FISCHEREIWISSENSCHAFT.	HOKKAIDO UNIV., SAPPORO (JAPAN).
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Diverse Use of the Marine Environment.	Fail.	lution Control in Enclosed Coastal Sea.
W91-10607 2I	. W91-11005 6A	W91-10567 5G

5G

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Snow Crystals Between -3 and -23 C. W91-10515 2C	Laboratory Measurements of Small Raindrop Distortion. Part I: Axis Ratios and Fall Behav-	INLAND WATERS DIRECTORATE,
HOLE, MONTES AND ASSOCIATES, INC., NAPLES, FL.	ior. W91-10513 2B	MONCTON (NEW BRUNSWICK), WATER QUALITY BRANCH.
Evaporative Drying of Dredged Material. W91-11000 5D	ILLINOIS STATE WATER SURVEY DIV., CHAMPAIGN. CLIMATOLOGY AND	Transport of the Fungicide Chlorothalonil from Its Operational Use on a Pond Ecosystem. W91-11299 5B
HOLLANDSE EILANDENEN WAARDEN	METEOROLOGY SECTION.  Hydrological Aspects of the 1988 Drought in	
WASTEWATER AUTHORITY, DORDRECHT (NETHERLANDS), Sludge Treatment and Tipping Site 'Hartel-	Illinois. W91-10810 2B	INLAND WATERS DIRECTORATE, OTTAWA (ONTARIO).  Industrial Water Pricing for Ontario: Towards
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HONG KONG UNIV. CENTRE OF URBAN	RESOURCES AND SYSTEMS ANALYSIS. Unit Hydrographs for Developing Design Flood	INSTITUT ARMAND-FRAPPIER, LAVAL
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W91-11439 5G		Prospective Epidemiological Study of Drinking Water Related Gastrointestinal Illnesses.
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(NETHERLANDS),	Dynamical Forcing and Mesoscale Organization of Precipitation Bands in a Midwest Winter Cy-	Elimination of Coliphages, Clostridium perfrin-
Removal of Heavy Metals from Sewage Sludge: State of the Art and Perspectives.	clonic Storm.	gens and Human Enteric Viruses During Drink- ing Water Treatment: Results of Large Volume
W91-11124 5D	W91-11424 2B	Samplings.
HUNAN UNIV., CHANGSHA (CHINA). DEPT.	ILLINOIS UNIV. AT URBANA-CHAMPAIGN.	W91-10654 5F
OF CHEMISTRY AND CHEMICAL	SCHOOL OF LIFE SCIENCES.  Acute Phototoxicity of Harbor and Tributary	INSTITUT DE RECHERCHES
ENGINEERING, Comparison of Amperometric and UV-Spectro-	Sediments from Lower Lake Michigan.	HYDROLOGIQUES, NANCY (FRANCE).
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	ATMOSPHERIC RESEARCH.  Numerical Simulations of the Evolution of a	Physical and Chemical Characterization of
HYOGO PREFECTURAL FISHERIES EXPERIMENTAL STATION, AKASHI (JAPAN).	Cold Front and its Precipitation. W91-11418 2B	Sewage Sludge. W91-11117 5D
Bloom of Coscinodiscus wailesii and DO Deficit	IMPERIAL CHEMICAL INDUSTRIES LTD.,	
of Bottom Water in Seto Inland Sea. W91-10549 5C	BRACKNELL (ENGLAND), PLANT PROTECTION DIV.	INSTITUT FRANCAIS DE RECHERCHE POUR L'EXPLOITATION DE LA MER,
HYOGO PREFECTURAL PUBLIC HEALTH	Solid-Phase Extraction for Multi-Residue Analy- sis of Some Triazole and Pyrimidine Pesticides	NANTES, LAB. EFFETS BIOLOGIQUES DES NUISANCES.
AND ENVIRONMENT DEPT., KOBE (JAPAN).	in Water.	Measurement of the Effect of Organic Pollution on Marine Organisms: Rapid Determination of
Environmental Management of the Seto Inland Sea.	W91-11313 5A	EROD Induction Using Plate Readers.
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W91-11376 5B	INDIAN SCHOOL OF MINES, DHANBAD.	an Acid Sandy Soil Treated with Sewage Sludge
IDAHO NATIONAL ENGINEERING LAB.,	Geotechnical Appraisal of the Foundation Rock Mass Behaviour of Narmada Sagar Dam	or Farmyard Manure in a Long Term Field
IDAHO FALLS. Improved Analysis of Gravity Drainage Experi-	Project, Central India: A Case Study.	Experiment. W91-11160 5E
ments for Estimating Unsaturated Soil Hydraulic	W91-10784 8E	
Functions. W91-11237 2G	INDIANA UNIV. AT BLOOMINGTON. DEPT.	INSTITUT NATIONAL DE LA RECHERCHE SCIENTIFIQUE, SAINTE-FOY (QUEBEC).
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Chelation.	INDUSTRIAL TOXICOLOGY RESEARCH	
W91-10894 5A	CENTRE, LUCKNOW (INDIA). PREVENTIVE	INSTITUT PASTEUR DE LILLE, VILLENEUVE D'ASCQ (FRANCE).
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INSTITUT RUDJER BOSKOVIC, ZAGREB (YUGOSLAVIA). CENTER FOR MARINE	INSTITUTO VALENCIANO DE INVESTIGACIONES AGRARIAS, VALENCIA	IOWA UNIV., IOWA CITY, DEPT. OF CIVIL AND ENVIRONMENTAL ENGINEERING.
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Conceptual Framework of Environmental Man- agement Strategies for Yugoslavia: The Case of the Adriatic Sea.	Chemical Properties of Sewage Sludges Produced in the Valencian Area (Spain). W91-11159 5A	Spodosol Fraction. W91-11233 5C
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Review of the Epidemiology and Diagnosis of	Coastal Sea Area and Measures for Protection. W91-10540 5B	Algae in Samarra Impoundment, Iraq. W91-11525 2H
Waterborne Viral Infections. W91-10651 5B	W91-10340	
	INSTITUUT VOOR MECHANISATIE, ARBEID	ISTITUTO DI MICROBIOLOGIA AGRARIA E
INSTITUTE OF ENVIRONMENTAL	EN GEBOUWEN, WAGENINGEN	STAZIONE DE MICROBIOLOGIA INDUSTRIALE, PORTICI (ITALY).
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INSTITUTE OF HYDROLOGY,	WASHINGTON, DC. AGRICULTURE DIV.	BARI (ITALY).
WALLINGFORD (ENGLAND).	Soil and Moisture Conservation Technologies:	Influence of Polyelectrolyte Characteristics on
Dynamic Model of Caesium Transport in Lakes	Review of Literature. W91-11565 4D	Sludge Conditioning (Lab Evaluations).
and Their Catchments. W91-10934 5B	W 91-11303	W91-10701 5D
W91-10934 3B	INTERNATIONAL BANK FOR	Technical Requirements and Possibilities of In-
Simazine Concentrations in a Stream Draining	RECONSTRUCTION AND DEVELOPMENT,	cineration.
an Agricultural Catchment. W91-11364 4C	WASHINGTON, DC. ENVIRONMENTAL POLICY RESEARCH DIV.	W91-11129 5D
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INSTITUTE OF KARST GEOLOGY, GUILIN	W91-11564 4D	Numerical Simulation of Water Quality in
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Environmental Isotope Study for Estimating Leakage and Runoff of Ground Waters in the	nologies.	W91-10528 5B
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W91-10994 2F	Economic Analysis of Off-Farm Soil Conserva-	Ecological Modelling at Osaka Bay Related to
INSTITUTE OF NUCLEAR ENERGY	tion Structures.	Long-Term Eutrophication.
RESEARCH, LUNG-TAN (TAIWAN).	W91-11567 4D	W91-10556 5C
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W91-11367 5D	MANILA (PHILIPPINES).	Existing Conditions for Agricultural Utilization
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INSTITUTE OF OCEANOGRAPHY AND FISHERIES, ALEXANDRIA (EGYPT).	W91-10523 5G	W91-11132
Incidence and Ecology of Marine Fouling Orga-	INTERNATIONAL INST. FOR APPLIED	JAWAHARLAL NEHRU UNIV., NEW DELHI
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Egypt. W91-10560 5C	(AUSTRIA).	SCIENCES.  Nature of Suspended Solids and IRS1A-LISSI
W91-10360	Danube River Basin: Negotiating Settlements to Transboundary Environmental Issues.	Data: A Case Study of Tawa Reservoir (Nar-
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Budget.		Estimation of Trace Metals Levels in Power and
W91-11071 2K	Fluctuating Great Lakes Water Levels: Progress	Industrial Waste Water of Jodhpur by Differen-
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Projects.	Successes and Challenges in Developing and	Drinking, Ground and Industrial Waste Water
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INSTITUTO DE PESQUISAS ESPACIAIS, SAO	Degraded Areas of the Great Lakes. W91-11030 6A	W91-11083 5B
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W91-11161 5E	Overview.	BIOGRAPHIQUES, PIREN EAU ALSACE,
JUNE LAKE PUBLIC UTILITY DISTRICT,	W91-11130 5E	FACULTE DE PHARMACIE BP 24, 67401 ILLKIRCH, FRANCE.
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CHEMISTRY. High-Performance Liquid Chromatographic	KIEL UNIV. (GERMANY, F.R.). ZOOLOGISCHES INST. UND MUSEUM.	LAHMEYER INTERNATIONAL GMBH, LYOMER STRASSE 22, D-6000, FRANKFURT,
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OF INFORMATION MANAGEMENT, Controlling Effect of the Planned Management	KING'S COLL., LONDON (ENGLAND). DIV.	W91-10989 2E
of the Environment in the Kagoshima Bay on	OF BIOSPHERE SCIENCES.	Cloud/Cryosphere Interactions.
the Pollutant Load. W91-10579 5G	Identity of Suspended Particles in a Calcite- Depositing Stream and Their Significance in	W91-11095 2B
KALYANI UNIV. (INDIA), DEPT, OF	Trapping and Binding Phenomena. W91-11522 2E	Major Incident of Dioxin Contamination: Sedi-
ZOOLOGY.	KINNERET LIMNOLOGICAL LAB.,	ments of New Jersey Estuaries. W91-11341 5B
Production of Chironomid Larvae in Culturing Media of Various Organic Wastes.	TIBERIAS (ISRAEL).	
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OF GEOGRAPHY.  Adoption of Water-Savings Practices by Irriga-	KITAKYUSHU MUNICIPAL INST. OF	W91-11442 6G
tors in the High Plains. W91-10821 3F	ENVIRONMENTAL HEALTH SCIENCES (JAPAN).	LANCASTER UNIV. (ENGLAND), INST. OF ENVIRONMENTAL AND BIOLOGICAL
KARL-MARX-UNIV., LEIPZIG (GERMAN	Recovery of Aquatic Animals in Dokai Bay, Northern Kyushu, Japan.	SCIENCES.  PCR and Environmental Monitoring: The Way
D.R.). DEPT. OF CHEMISTRY. Flow-Rate Variated HPLC-/EC-Determination	W91-10550 5G	Forward. W91-10670 5A
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KARLSRUHE UNIV. (GERMANY, F.R.). LEHRSTUHL FUER ANGEWANDTE	KOREA OCEAN RESEARCH AND	BUNDESANSTALT, LINZ (AUSTRIA).
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KATHOLIEKE UNIV. NIJMEGEN	W91-10526 5B	LANDWIRTSCHAFTLICHE
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KERNFORSCHUNGSANLAGE JUELICH	W91-11001 5B	densis) from a Watershed Containing U Tailings Near Elliot Lake, Canada.
G.M.B.H. (GERMANY, F.R.). INST. FUER	LABORATOIRE D'HYGIENE DE LA VILLE	W91-11454 5B
BIOTECHNOLOGIE.  1-Naphthalenesulfonic acid and Sulfate as Sulfur	DE PARIS (FRANCE).  Detection of Hepatitis A Virus and Other Enter-	LAVAL UNIV., QUEBEC, DEPT. OF CIVIL
Sources for the Green Alga Scenedesmus obli-	oviruses in Wastewater and Surface Water Sam-	ENGINEERING.
quus. W91-11326 5D	ples by Gene Probe Assay. W91-10665 5A	Dynamic Simulation of Storm Tanks. W91-10928 5D

RECHERCHE EN RECYCLAGE	MAHARASHTRA ASSOCIATION FOR THE CULTIVATION OF SCIENCE, POONA	MARINE PRODUCTS EXPORT DEVELOPMENT AUTHORITY, COCHIN
BIOLOGIQUE ET AQUICULTURE.	(INDIA). DEPT. OF MICROBIOLOGY.	(INDIA).
Comparative Study and Mathematical Modeling	Activated Sludge Process to Reduce the Pollu-	Effects of Oil Pollution on Bio-Ecology and
of Temperature, Light and Growth of Three	tion Load of a Dye-Industry Waste. W91-11455 5D	Fisheries on Certain Enclosed Coastal Regions
Microalgae Potentially Useful for Wastewater Treatment.	W91-11433	of Arabian Sea. W91-10555 5B
W91-10937 5D	MAINE MEDICAL CENTER, PORTLAND.	W91-10555 5B
TAMBENCE DEDUCTED TABLES CA CADATI	DEPT. OF RESEARCH.	MARYLAND UNIV., CAMBRIDGE. CENTER
LAWRENCE BERKELEY LAB., CA. EARTH SCIENCES DIV.	Radon in Homes Following Its Reduction in a Community Water Supply. W91-11464 5B	FOR ENVIRONMENTAL AND ESTUARINE STUDIES.
New Approach to Tracer Transport Analysis: From Fracture Systems to Strongly Heterogene-	W91-11404 3B	Environmental Research, Policy and Regula-
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W91-11554 2F	ENGINEERING. Measuring Low Radon Levels in Drinking	W91-10575 5G
LAWRENCE LIVERMORE NATIONAL LAB., CA. ATMOSPHERIC AND GEOPHYSICAL	Water Supplies. W91-11463 5A	MARYLAND UNIV., COLLEGE PARK. DEPT. OF ZOOLOGY.
SCIENCES DIV.		Drift of the Characin Larvae, Bryconamericus
Observational and Theoretical Studies of Green-	MAINZ UNIV. (GERMANY, F.R.). INST. FUER ZOOLOGIE.	deuterodonoides, During the Dry Season from
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CA. ENVIRONMENTAL RESTORATION DIV.	W91-10828 5A	MARYLAND UNIV., SOLOMONS. CENTER FOR ENVIRONMENTAL AND ESTUARINE
Remedial Investigation of the High Explosives	MALAGA UNIV. (SPAIN). DEPT. DE	STUDIES.
Burn Pit Facility, Building 829 Complex, Law-	INGENIERIA QUIMICA.	Improved Policy Instruments for Management
rence Livermore National Laboratory Site 300. W91-10731 5B	Soil Clean Up by In-situ Aeration: VI. Effects of	of Enclosed Coastal Seas and Estuaries: The
	Variable Permeabilities. W91-11317 5G	Chesapeake Bay, USA. W91-10610 2L
LEEDS POLYTECHNIC (ENGLAND).	W91-11317	W >1-10010
SCHOOL OF THE ENVIRONMENT. Seasonal Changes in the Sanitary Bacterial Qual-	MALAGA UNIV. (SPAIN). FACULTAD DE	MARYLAND UNIV., SOLOMONS.
ity of Water Draining a Small Upland Catch-	CIENCIAS.  Relationship Between Pseudomonas aeruginosa	CHESAPEAKE BIOLOGICAL LAB.
ment in the Yorkshire Dales.	and Bacterial Indicators in Polluted Natural	Rise and Fall of the Potomac River Striped Bass Stock: A Hypothesis of the Role of Sewage.
W91-10935 5B	Waters.	W91-11529 5C
LEEDS UNIV. (ENGLAND). DEPT. OF CIVIL	W91-10635 5A	
ENGINEERING.	MALAYA UNIV., KUALA LUMPUR	MASSACHUSETTS DIV. OF WATER SUPPLY,
Influence of Reactor Mixing Characteristics on the Rate of Nitrification in the Activated Sludge	(MALAYSIA), INST. FOR ADVANCED	BOSTON. Wellhead Protection in Massachusetts: Protect-
Process.	STUDIES.	ing Public Water Supplies from Pesticide Im-
W91-10932 5D	Urbanization and Urban Water Problems in Southeast Asia: A Case of Unsustainable Devel-	pacts.
A THIRD OF THE OTHER PORT OF THE PORT OF T	opment.	W91-11182 5G
LENINGRAD TECHNOLOGICAL INST. FOR THE PULP AND PAPER INDUSTRY (USSR).	Ŵ91-11263 6G	MASSACHUSETTS INST. OF TECH.,
Thermocatalytic and Chemical Treatment of	Assessment of Water Pollution using Diatom	CAMBRIDGE, DEPT, OF CIVIL
Lignin-Aluminium Sludge and Utilization of the	Community Structure and Species Distribution-	ENGINEERING.
Resulting Adsorbent-Coagulant. W91-11503 5D	A Case Study in a Tropical River Basin.	Hydrologic Science: A Distinct Geoscience. W91-11429 2A
1171 1100	W91-11404 5C	W91-11429 2A
LIMNOLOGISCH INST., NIEUWERSLUIS	MANGALORE UNIV. (INDIA). DEPT. OF	MASSACHUSETTS UNIV., AMHERST. DEPT.
(NETHERLANDS). VIJVERHOF LAB.  Ion Concentrations in Interstitial Water as Indi-	CHEMISTRY.	OF CIVIL ENGINEERING.
cators for Phosphorus Release Processes and	Studies on Assessment of Water Balance and Its Quality in Gurpur River Basin, Karnataka State,	Removal of Humic Substances and Algae by
Reactions.	India.	Dissolved Air Flotation. W91-10751 5F
W91-10888 2K	W91-11065 5B	#71-10/31
LINKOEPING UNIV. (SWEDEN), DEPT. OF	MANITOBA UNIV., WINNIPEG. DEPT. OF	Field Sampling of Residual Aviation Gasoline in
WATER AND ENVIRONMENTAL	CIVIL ENGINEERING.	Sandy Soil. W91-10795 5A
RESEARCH.	Knowledge-Based Systems and Operational Hy-	W91-10795 5A
Organohalogens of Natural and Industrial Origin In Large Recipients of Bleach-Plant Effluents.	drology. W91-11273 7C	Biodegradation of Hydrocarbon Vapors in the
W91-11505 5B	W91-112/3	Unsaturated Zone.
	Risk-based Performance Criteria for Real-time	W91-11227 5E
Formation of Chlorophenols and Related Com- pounds In Natural and Technical Chlorination	Reservoir Operation. W91-11275 4A	MASSACHUSETTS UNIV., AMHERST. DEPT.
Processes.	W91-112/3	OF POLITICAL SCIENCE.
W91-11508 5B	MANITOBA UNIV., WINNIPEG. DEPT. OF	Towards Management of Environmental Prob
LOCKHEED-EMSCO, LAS VEGAS, NV.	GEOLOGICAL ENGINEERING.	lems in Egypt.
Occurrence of Appendix IX Organic Constitu-	Geostatistical Characteristics of the Borden Aq- uifer.	W91-11373 6G
ents in Disposal Site Ground Water.	W91-11234 2F	MASSEY UNIV., PALMERSTON NORTH
W91-10801 5B	MARKET PLOT OCUCAL TAR MICORS HOLE	(NEW ZEALAND).
LUND UNIV. (SWEDEN), DEPT. OF	MARINE BIOLOGICAL LAB., WOODS HOLE, MA. ECOSYSTEMS CENTER.	Influence of Flooded Soil on Chemical Compo
ECOLOGICAL CHEMISTRY.	Role of Seasonal Turnover in Lake Alkalinity	sition of Annual Ryegrass and Digestibility by
Dispersal Dynamics of Groundwater Bacteria.	Dynamics.	Meadow Voles. W91-11536 21
W91-10843 5B	W91-10861 2H	
LUND UNIV. (SWEDEN). DEPT. OF	MARINE ECOLOGICAL SURVEYS LTD.,	MAX-PLANCK-INST. FUER CHEMIE, MAINZ
ECOLOGY.	FAVERSHAM (ENGLAND).	(GERMANY, F.R.).
Riparian Zone as a Source of Phosphorus for a	Modification of Benthic Community Structure	Zonal Average Cloud Characteristics for Globa Atmospheric Chemistry Modelling.
Groundwater-Dominated Lake. W91-10931 2H	in Response to Acid-Iron Wastes Discharge. W91-10869 5C	W91-10728 2E

2B

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ZU PLOEN (GERMANY, F.R.).	BIOLOGY.	ted With Half-Circular Concrete Pipes. Results
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Medium. W91-10779 5G	Jets.	W91-10530 5G
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ENGINEERING MECHANICS.	MICHIGAN UNIV., ANN ARBOR, DEPT. OF ENVIRONMENTAL AND WATER	BUREAU.
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Ontario. W91-10978 2H	Sorption Phenomena in Subsurface Systems:	ures in Seto Inland Sea.
	Concepts, Models, and Effects on Contaminant	W91-10545 5G
MCNEES, WALLACE AND NURICK, HARRISBURG, PA.	Fate and Transport. W91-10882 5B	MINIECOTA BOLLUTION CONTROL
Toxics Reduction: The Legal Framework.	71-10002 3B	MINNESOTA POLLUTION CONTROL AGENCY, ROSEVILLE.
W91-11538 6E	Theoretical Study of the Significance of None-	Minnesota Clean Water Partnership Program.
MEDIZINISCHE AKADEMIE 'CARL GUSTAV	quilibrium Dissolution of Nonaqueous Phase Liquids in Subsurface Systems.	W91-11181 5G
CARUS' DRESDEN (GERMAN D.R.).	W91-11228 5B	MININESOTA LINIU MININEADOLIC DEPT
Virological Investigation of the River Elbe. W91-10652 5B	771-11220	MINNESOTA UNIV., MINNEAPOLIS. DEPT. OF CIVIL AND MINERAL ENGINEERING.
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River.	W91-11011 6B	ANTHONY FALLS HYDRAULIC LAB.
W91-10632 5B		Scour at Cantilevered Pipe Outlets, Plunge, Pool
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(AUSTRALIA). CENTER FOR NATURAL RESOURCES LAW.	(ENGLAND), URBAN POLLUTION RESEARCH CENTER.	W91-10/22
Tensions Between Water Legislation and Cus-	Bacterial Water Quality in Urban Receiving	MINNESOTA UNIV., ST. PAUL. DEPT. OF
tomary Rights.	Waters.	AGRICULTURAL AND APPLIED
W91-11383 6E	W91-10633 5B	ECONOMICS.  Political Economic Model of International Pol-
MELBOURNE UNIV., PARKVILLE	MILLSAPS COLL., JACKSON, MS. DEPT. OF	lution.
(AUSTRALIA), DEPT. OF GEOLOGY. Geochemical Evidence Supporting T. C. Cham-	GEOLOGY.	W91-11016 5B
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W91-10790 2C	Comparative Efficacy of Commercially Avail- able Polypropylene Sorbent Booms.	Water Quality Improvement: Measuring the
MEMORIAL UNIV. OF NEWFOUNDLAND,	W91-11447 5G	Benefits of Increased Information.
ST. JOHN'S. CENTRE FOR COLD OCEAN		W91-11052 3F
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Sediments. W91-10981 2J	Basin.	Advances in Wind and Water Erosion Predic-
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METEOROLOGISCHER DIENST DER DDR,	MINISTRY OF AGRICULTURE, FISHERIES	
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Acid Rain Abatement. W91-10477 5G	W91-10925 5B	CHEMICAL ENGINEERING.  Colour Removal from Textile Effluents by Ad-
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W91-10873 5B	W91-11347 2G	crophytes in the Network of the River Rhone. W91-11402 2H
METSA-SERIA OY, 08800 KIRKNIEMI,	MINISTRY OF PHYSICAL PLANNING,	
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phosate and Aminomethylphosphonic Acid	ESCCP Cloud Data Products.	Tokyo Bay.
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Study. W91-11261 5A	NATIONAL BACTERIOLOGICAL LAB.,	NATIONAL INCE FOR ENGINOSISCENTAL
	STOCKHOLM (SWEDEN).	NATIONAL INST. FOR ENVIRONMENTAL STUDIES, TSUKUBA (JAPAN), WATER AND
MONTANA STATE UNIV., BOZEMAN.	Waterborne Disease Outbreak. W91-10615 5C	SOIL ENVIRONMENT DIV.
WATER RESOURCES RESEARCH CENTER.	W91-10015	Runoff Characteristics of COD, BOD, C, N, and
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W91-11039 6E	ENVIRONMENT, HELSINKI (FINLAND).	Seas.
	Staphylococci in Polluted Waters and in Waters	W91-10521 5B
MONTPELLIER-2 UNIV. (FRANCE). LAB.	of Uninhabited Areas. W91-10631 5B	
D'HYDROGEOLOGIE.	W91-10031 3B	NATIONAL INST. OF MULTIMEDIA
Deforestation and Leaching of Nitrogen as Ni- trates into Underground Water in Intertropical	NATIONAL BOARD OF WATERS, HELSINKI	EDUCATION, CHIBA (JAPAN).  Water Control Systems and the Traditional Fes-
Zones: The Example of Cote d'Ivoire.	(FINLAND).	tival at Miyawaki, on the Seto Inland Sea.
W91-11446 2F	Trends In Water Pollution Control In the Finn-	W91-10591 3F
	ish Pulp and Paper Industry. W91-11468 5G	
MOSCOW STATE UNIV. (USSR). DEPT. OF	W91-11400	NATIONAL MARINE FISHERIES SERVICE,
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mineralized Water.	Effects of Climate Change on Discharges and	plankton.
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by Flow Injection Analysis with Chemilumines-	Convective Cell in a Hurricane Rainband.	RESEARCH LAB.
cence Detection.	W91-11422 2B	Size Structure of Particulate Biogenic Silica in
W91-10773 2K	Approaches to the Simulation of Regional Cli-	Lake Michigan.
MOUNT BOWAL COLL CALCARY	mate Change: A Review.	W91-10975 2H
MOUNT ROYAL COLL., CALGARY (ALBERTA), DEPT. OF CHEMICAL AND	W91-11427 5C	Institutional Morass: Constraints and Opportuni-
BIOLOGICAL SCIENCES.	NATIONAL COUNCIL OF THE BARER	ties for Issue Management.
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Organic Compounds From Waste Disposal	IMPROVEMENT, INC., NEW YORK.	
Sites: Transformations and Behavior.	Goals, Regulations and Information Needs for	Great lakes Hydrological Impacts of 2xCO2 Cli-
W91-11378 5B	Wastewater Discharge ManagementAn Ameri-	mate Change.
NAGARJUNA UNIV., NAGARJUNANAGAR	can Perspective.	W91-11061 5C
(INDIA), DEPT. OF ZOOLOGY.	W91-11471 5G	NAME OF THE OWNER OWNER OF THE OWNER OWNER OF THE OWNER OWNE
Standard Test Fish for India and the Neighbor-	NATIONAL ECOLOGY RESEARCH CENTER,	NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, PRINCETON, NJ.
ing Countries.	FORT COLLINS, CO.	GEOPHYSICAL FLUID DYNAMICS LAB.
W91-11300 5A	Negotiation Techniques to Resolve Western	Refinement of the Combination Equations for
NAGASAKI PREFECTURE INST. OF	Water Disputes. W91-10817 6E	Evaporation.
HEALTH SCIENCE AND ENVIRNOMENTAL	W91-10817 6E	W91-11398 2K
SCIENCE (JAPAN).	Aquatic Habitat Measurement and Valuation:	
Formation of Oxygen-Deficient Water Mass in	Imputing Social Benefits to Instream Flow	Sensitivity Studies of Tropical Storm Genesis
Omura Bay. W91-10592 5B	Levels.	Using a Numerical Model. W91-11421 2B
W 91-10392 3B	W91-11266 7C	W91-11421 2B
NANCY-1 UNIV. (FRANCE). FACULTE DE	NATIONAL FISHERIES CONTAMINANT	NATIONAL OCEANIC AND ATMOSPHERIC
PHARMACIE,	RESEARCH CENTER, JACKSON, WY.	ADMINISTRATION, SEATTLE, WA. PACIFIC
Recovery of Enterovirus from Primary Sludge	JACKSON FIELD STATION.	MARINE ENVIRONMENTAL LAB.
Using Three Elution Concentration Procedures. W91-10657 5A	Sensitivity of Greenback Cutthroat Trout to	Remobilization of Cu from Marine Particulate
W 91-1003/	Acidic pH and Elevated Aluminum. W91-11531 5C	Organic Matter and from Sewage.
Detoxification by Sephadex LH20 of Seafood	W91-11331	W91-10923 5B
Concentrates for Rotavirus Assay.	NATIONAL FISHERIES RESEARCH	NATIONAL OCEANIC AND ATMOSPHERIC
W91-10696 5A	CENTER, LA CROSSE, WI.	ADMINISTRATION SILVED SPRING MD
Comparison of Two Methods for the Recovery	Species Composition of Fish Communities in	AIR RESOURCES LAB.
of Rotavirus from Mussels and Oysters.	Northern Wisconsin Lakes: Relation to pH. W91-10725 5C	Relation of Atmospheric CO2 to Tropical Sea
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NANSEI REGIONAL FISHERIES RESEARCH	INST., HYDERABAD (INDIA).	
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Flagellates Chattonella (Raphidophyceae) in the	W91-10949 0E	ADMINISTRATION, WASHINGTON, DC. CLIMATE ANALYSIS CENTER.
Seto Inland Sea.	NATIONAL HYDROLOGY RESEARCH INST.,	Empirical Method of Estimating Raingage and
W91-10546 5B	SASKATOON (SASKATCHEWAN).	Radar Rainfall Measurement Bias and Resolu-
NAMED AND DESCRIPTION OF THE ORIGINAL PROPERTY.	Variation of the Stable Isotopes of Water with	tion
NATIONAL AERONAUTICS AND SPACE	Altitude in the Saint Elias Mountains of Canada. W91-11220 2C	
ADMINISTRATION, GREENBELT, MD. GODDARD SPACE FLIGHT CENTER.	W 31-11220 2C	
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Surfaces in Northern Minnesota.	STUDIES, IBARAKI (JAPAN).	ADMINISTRATION, WASHINGTON, DC.
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NATIONAL RESEARCH CENTRE, CAIRO		W91-11046 6E
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Activated Sodium Carbonate. W91-11080 5G	W91-10737 5D	ECONOMICS. Willingness-to-Pay for Protection of Water Sup-
NATIONAL RESEARCH CENTRE, CAIRO	NEBRASKA UNIVLINCOLN. DEPT. OF	plies in Four Massachusetts' Towns.
(EGYPT), WATER POLLUTION CONTROL LAB.	CIVIL ENGINEERING.  Decision Support System for Water Transfer	W91-11056 6C
Need for New Microbiological Water Quality	Evaluation. W91-11226 6A	NEW YORK STATE PUBLIC SERVICES COMMISSION, ALBANY.
Criteria. W91-10621 5F	NEUCHATEL UNIV. (SWITZERLAND), INST.	Great Lakes Charter: Potential and Reality.
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Athens Area. W91-11416 2B	NEVADA UNIV. SYSTEM, RENO. DESERT RESEARCH INST.	pounds In Pulp Bleaching Effluents. W91-11484 5D
NATIONAL RESEARCH COUNCIL OF	Assessment of the Salinity Tolerance of Eight Sonoran Desert Riparian Trees and Shrubs.	NEW ZEALAND FOREST PRODUCTS LTD.,
CANADA, MONTREAL (QUEBEC). MONTREAL LAB.	W91-10752 3C	TOKOROA.  Identification of Dioxin Sources In an Integrated
Effect of NSSC Spent Liquor on Granule For- mation and Specific Microbial Activities In	NEW BRUNSWICK DEPT. OF	Wood Processing Facility.
Upflow Anaerobic Reactors. W91-11482 5D	TRANSPORTATION, FREDERICTON. MATERIALS AND RESEARCH BRANCH.	W91-11475 5B
	Change in Pore Size Distribution Owing to Sec- ondary Consolidation of Clays.	NICE UNIV. (FRANCE). MARINE ENVIRONMENT LAB,
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ENVIRONMENTAL CHEMISTRY. Effect of a Chelating Agent (DTPA) on Anaero-	NEW HAMPSHIRE UNIV., DURHAM. DEPT.	toral Zone Along the Southeastern Mediterrane- an Shore of Continental France.
bic Wastewater Treatment in an Upflow Sludge	OF MICROBIOLOGY.  Application of a Poliovirus cDNA Probe for the	W91-10562 6G
Blanket Filter. W91-11277 5D	Detection of Enteroviruses in Water. W91-10667 5A	NIHON UNIV., TOKYO, DEPT. OF CIVIL ENGINEERING.
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ENGINEERING AND TECHNICAL SYSTEMS.	COMMUNITY DEVELOPMENT.	
Using Oil Spill Dispersants on the Sea. W91-10716 5G	Ground Water Contamination from Agricultural Sources: Implications for Voluntary Policy Ad- herence from Iowa and Virginia Farmer's Atti-	NJALA UNIV. COLL., FREETOWN (SIERRA LEONE). DEPT. OF ENVIRONMENTAL STUDIES AND GEOGRAPHY.
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(JAPAN).	W91-11437 5G	Rural Sierra Leone. W91-11358 6B
Distribution of Chlorobenzenes in the Bottom Sediments of Ise Bay.	NEW JERSEY DEPT. OF ENVIRONMENTAL PROTECTION, TRENTON. DIV. OF WATER	NORMANDEAU ENCINEERS INC
W91-11324 5B	RESOURCES. Future Directions for Water Resources.	NORMANDEAU ENGINEERS, INC., CONCORD, NH
Behavior of Chlorobenzenes in Ise Bay, Estimat- ed from Their Concentrations in Various Envi-	W91-11208 4A	Road Salting Impacts in Massachusetts. W91-11053 4C
ronmental Media. W91-11325 5B	NEW JERSEY INST. OF TECH., NEWARK.	NORSK HYDROTEKNISK LAB.,
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NATIONAL SEVERE STORMS LAB., NORMAN, OK.	Using Immobilized Activated Sludge. W91-11381 5D	Design and Performance of the BIOFISH Water Recirculation System.
Electrical and Kinematic Structure of the Strati- form Precipitation Region Trailing an Oklahoma	NEW MEXICO UNIV., ALBUQUERQUE.	W91-11548 5D
Squall Line.	SCHOOL OF LAW.	NORSK INST. FOR VANNFORSKNING,
W91-10514 2B	Legal Regimes for Interstate Water Allocation in the Western United States: Some Successes	OSLO.  Algicidal and Chemical Effect of u.vRadiation
Use of Single-Doppler Radar for Estimating Maximum Hailstone Size.	and Failures. W91-11008 6E	of Water Containing Humic Substances. W91-10941 5F
W91-10858 2B	NEW SOUTH WALES UNIV., KENSINGTON	NORSK PETROLEUMSINSTITUTT, OSLO.
NATIONAL SOIL EROSION LAB., WEST LAFAYETTE, IN.	(AUSTRALIA). CENTRE FOR GROUNDWATER MANAGEMENT AND	Biotechnology Degradation and Mitigation of Offshore Oil Spills, Phase 1. Main Report: Tech-
WEPP: A New Generation of Erosion Predic- tion Technology.	HYDROGEOLOGY.  Hydrochemistry of a Groundwater-Seawater	nology to Enhance Biodegradation of Oil Spills
W91-10511 2J	Mixing Zone, Nauru Island, Central Pacific Ocean.	gy Development.
WEPP: Soil Erodibility Experiments for Range-	W91-11297 2K	W91-10735 5G
land and Cropland Soils. W91-10512 2J	NEW YORK BOTANICAL GARDEN, BRONX, NY. INST. OF ECOSYSTEM STUDIES.	NORTH CAROLINA STATE UNIV. AT RALEIGH. DEPT. OF MARINE, EARTH AND
NATIONAL SWEDISH ENVIRONMENT PROTECTION BOARD, SOLNA.	Impact of Changing Regional Emissions on Pre- cipitation Chemistry in the Eastern United	Interannual Variability in Acidic Deposition on
Integrated Management of the Baltic Sea. W91-10580 5G	States. W91-10473 5G	the Mt. Mitchell Area Forest. W91-10478 5E

PADUA UNIV. (ITALY). DEPT. OF BIOLOGY.

NORTH CAROLINA UNIV. AT	OHIO DEPT. OF NATURAL RESOURCES,	ORECON ACRICULTURAL CHEMICAL
WILMINGTON, DEPT. OF BIOLOGICAL	COLUMBUS, DIV. OF WATER.	OREGON AGRICULTURAL CHEMICAL ASSOCIATION, SALEM.
SCIENCES.	Application of the DRASTIC Mapping System	Oregon Pesticide Container Initiative.
Natural Phosphate Source for Lake Waccamaw,	for Evaluating Ground Water Pollution Poten- tial in Ohio.	W91-11192 5E
North Carolina, USA. W91-11405 2H	W91-11178 5B	
**/1-11403		OREGON STATE UNIV., CORVALLIS. DEPT. OF GEOSCIENCES.
NORTH CAROLINA UNIV., CHAPEL HILL.	OHIO STATE UNIV., COLUMBUS, DEPT. OF GEOLOGY AND MINERALOGY.	Managing Oregon's Estuarine Resources Lands.
DEPT. OF ENVIRONMENTAL SCIENCES	Delineation of Traveltime-Related Capture	W91-10508 2L
AND ENGINEERING.	Areas of Wells Using Analytical Flow Models	177 10000
Comparative Inactivation of Hepatitis A Virus and Other Enteroviruses in Water by Iodine.	and Particle-Tracking Analysis.	ORISSA UNIV. OF AGRICULTURE AND
W91-10679 5F	W91-10957 2F	TECHNOLOGY, BHUBANESWAR (INDIA).
	OK TEDI MINING LTD., PORT MORESBY	Leaching of Ammonium Nitrate under Field
NORTH DAKOTA STATE UNIV., FARGO.	(PAPUA NEW GUINEA).	Conditions: Studies on Kinetics of Nitrification
DEPT. OF CIVIL ENGINEERING.	Off-River Storages as Sources and Sinks for	and Nitrate Reduction in an Ultisol Profile. W91-10999 5B
Review of Interbasin Water Transfers with Spe- cific Attention to Biota.	Environmental Contaminants. W91-10851 5B	W 51-10339
W91-11013 6B		OSAKA BAY CENTER FOR REGIONAL
	OKLAHOMA STATE UNIV., STILLWATER.	OFFSHORE LAND RECLAMATION, BINGO-
NORTH DAKOTA UNIV., GRAND FORKS.	SCHOOL OF CIVIL ENGINEERING. In-Situ Sediment Oxygen Demand in Five	MACHI 4-1-3, CHUOKU, OSAKA, 541 JAPAN.
DEPT. OF BIOLOGY.	Southwestern U.S. Lakes.	Regional-Wide Waste Disposal Project on Sea-
Short-Term Effects of a Catastrophic Beaver Dam Collapse on a Stream Fish Community.	W91-11333 2H	coast of Enclosed Coastal Sea. W91-10594 5E
W91-11558 2E	OKLAHOMA UNIV., NORMAN. DEPT. OF	W91-10394 3E
	ZOOLOGY.	OSAKA CITY INST. OF PUBLIC HEALTH
NORTH DAKOTA UNIV., GRAND FORKS.	Upstream Extirpation of Four Minnow Species	AND ENVIRONMENTAL SCIENCES (JAPAN).
DEPT. OF CIVIL ENGINEERING.  Removal of Biota from Inter-Basin Transfer	Due to Damming of a Prairie Stream.	Succession of Benthic Assemblages in Wild Bird
Water.	W91-11535 6G	Park, a Sanctuary Established on Reclaimed
W91-11017 5F	OKLAHOMA UNIV., NORMAN, INST. FOR	Land in Osaka Port.
	APPLIED SURFACTANT RESEARCH.	W91-10606 2L
NORTH-EASTERN HILL UNIV., SHILLONG	Use of Ligand-Modified Micellar-Enhanced Ul-	OSAKA GELJUTSU UNIVERSITY,
(INDIA). DEPT. OF BOTANY.	trafiltration in the Selective Removal of Metal Ions from Water.	DEPARTMENT OF ENVIRONMENTAL
Inhibition of NO3(-), NH4(+), and PO4(3-) Uptake in Anabaena doliolum Exposed to a Pe-	W91-11318 5D	PLANNING, OSAKA PREFECTURE, 585
troleum Oil.		JAPAN.
W91-10825 5C	OKLAHOMA UNIV., NORMAN, SCHOOL OF CIVIL ENGINEERING AND	Toward Environmental Planning for East Asian
	ENVIRONMENTAL SCIENCE.	Estuaries: Japanese and Chinese Enclosed Bays.
Regulatory Influence of Water Current on Algal	Characteristics of Rhodamine WT and Fluores-	W91-10565 2L
Colonization in an Unshaded Stream at Shillong (Meghalaya, India).	cein as Adsorbing Ground-Water Tracers. W91-10952 5B	OSAKA PREFECTURE ENGINEERING
W91-11451 2E	W91-10952 5B	OFFICE, 210, OGURA, WAKAYAMA, 649-62
	OLD DOMINION UNIV., NORFOLK, VA.	JAPAN.
NORTH SURREY WATER CO., STAINES	DEPT. OF BIOLOGICAL SCIENCES.	Water Quality Purification System for the En-
(ENGLAND).  Cryptosporidiosis and Water Supply: A Brief	Sediment Denitrification Potential in the Eliza- beth River, Virginia.	closed Sea Area. W91-10596 5G
Review, with Special Reference to the Report of	W91-11537 5C	W91-10596 5G
the Badenoch Committee.		OSAKA PREFECTURE WATER WORKS
W91-11271 5F	OLMSTED COUNTY HEALTH DEPT.,	BUREAU (JAPAN).
NORTHERN AREAS BURY IS WORKS DEPT	ROCHESTER, MN. DIV. OF ENVIRONMENTAL HEALTH.	Sea and Fresh Water Conservation.
NORTHERN AREAS PUBLIC WORKS DEPT., GILGIT (PAKISTAN).	Minnesota's Olmsted County: A Cooperative	W91-10578 5G
Development of Small Hydro for Remote Areas	Health Based Perspective on Zoning and Plan-	
of Northern Pakistan.	ning. W91-11187 6B	OSAKA UNIV. (JAPAN).
W91-11215 8C	W)1-1110/	Personal Computer System Supporting Water Quality Management in Eutrophicated Bay.
OAK RIDGE NATIONAL LAB., TN.	ONTARIO MINISTRY OF NATURAL	W91-10582 50
ANALYTICAL CHEMISTRY DIV.	RESOURCES, MAPLE, FISHERIES BRANCH. Chemical and Biological Factors Affecting Acid	.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Direct Sampling Ion Trap Mass Spectrometry	Tolerance of Smallmouth Bass.	OSAKA UNIV. (JAPAN). DEPT. OF CIVIL
for the Rapid Determination of Volatile Organ-	W91-11530 5C	ENGINEERING.
ics in Environmental Matrices.	ONTARIO MINISTRY OF NATURAL	Outflow and Three-Dimensional Spreading of
W91-11555 5A	RESOURCES, TORONTO. CONSERVATION	River Water in Enclosed Bay. W91-10525 21
OAK RIDGE NATIONAL LAB., TN.	AUTHORITIES AND WATER MANAGEMENT	W 91-10323
ENVIRONMENTAL SCIENCES DIV.	BRANCH.	OXFORD UNIV. (ENGLAND), SOIL SCIENCE
Treatability of Hazardous Chemicals in Soils:	Provincial Guidelines to Great Lakes Shoreline Management Plans.	LAB.
Volatile and Semivolatile Organics.	W91-11024 6E	Model of Ammonia Volatilization From Applie
W91-10712 5B		Urea. V. The Effects of Steady-State Drainag and Evaporation.
Utility of Multiple-Completion Monitoring	ONTARIO MINISTRY OF THE	W91-10805 31
Wells for Describing a Solvent Plume.	ENVIRONMENT, LONDON. TECHNICAL SUPPORT SECTION.	W 71-10003
W91-10800 7A	Coliphage and Bacteriophage as Indicators of	Model of Ammonia Volatilization From Applie
Atmospheric Carbon Dioxide and the Global	Recreational Water Quality.	Urea. VI. The Effects of Transient-State Water
Carbon Cycle: The Key Uncertainties.	W91-11334 5A	Evaporation.
W91-11068 5B	ONTARIO MINISTRY OF THE	W91-10806
	ENVIRONMENT, TORONTO. WATER	PADUA UNIV. (ITALY). DEPT. OF BIOLOGY
ODESSKII GOSUDARSTVENNYI UNIV.	RESOURCES BRANCH.	
(USSR).  Physical Properties of Irrigated Chernozems of	Statistical Characterization of Atrazine Residues in Southwestern Ontario Great Lakes Tributar-	D 1 D 1 11 11 17 17 11 17 17
the Southern Ukraine.	ies.	cica).
3701 10015	W01-11064 5B	W91-10518 56

#### PADUA UNIV. (ITALY). DEPT. OF BIOLOGY.

TABLE CITY (HALL), DE II CI BIOLOGIA		
Effects of Linear Alkylbenzene Sulphonate (LAS) on Skeletal Development of Sea Urchin Embryos (Paracentrotus lividus LMK).	PHILIPPINES UNIV., DILIMAN, QUEZON CITY. MARINE SCIENCE INST. Seagrass-Mangrove Ecosystems Management: A	PRETORIA UNIV. (SOUTH AFRICA). DEPT. OF MEDICAL VIROLOGY.
W91-10891 5C	Key to Marine Coastal Conservation in the ASEAN Region.	Microbiological Methods for Safety Testing of Drinking Water Directly Reclaimed from Wastewater.
PAN AMERICAN CENTER FOR SANITARY ENGINEERING AND ENVIRONMENTAL	W91-10539 5G	W91-10613 5A
SCIENCES, LIMA (PERU). Simplified Phosphorus Trophic State Model for	PHYSICAL RESEARCH LAB., AHMEDABAD	Assessment of Methods for the Microbiological
Warm-Water Tropical Lakes.	(INDIA).  Evidence of Chernobyl Fallout on a Temperate	Analysis of Shellfish.
W91-11332 5C	Himalayan Glacier.	W91-10695 5A
PAPIERTECHNISCHE STIFTUNG FUER	W91-10950 5B	PRINCETON UNIV., NJ. DEPT. OF CIVIL
FORSCHUNG UND AUSBILDUNG IN PAPIERERZEUGUNG UND -	PIRA, LEATHERHEAD (ENGLAND). PAPER AND BOARD DIV.	ENGINEERING AND OPERATIONS RESEARCH.
VERARBEITUNG, MUNICH (GERMANY, F.R.). WASSER- UND	Biological Bleaching of Wood PulpsA Viable	Estimation of the Mean Field Bias of Radar
ABWASSERFORSCHUNGSSTELLE. Closing Paper Mill Whitewater Circuits by In-	Chlorine-Free Bleaching Technology. W91-11476 5G	Rainfall Estimates. W91-10857 2B
serting an Anaerobic Stage with Subsequent Treatment.	PISA UNIV. (ITALY). DIPT. DI SCIENZE	PROUDMAN OCEANOGRAPHIC LAB.,
W91-11477 5G	DELL'AMBIENTE E DEL TERRITORIO.  Trace Element Distribution in Surficial Sedi-	BIRKENHEAD (ENGLAND).
PAQUES B.V., BALK (NETHERLANDS).  Anaerobic Treatment of Bleached TMP and	ments of the Northern Tyrrhenian Sea: Contri- bution to Heavy-Metal Pollution Assessment.	5-Year Scientific Research Programme for Managing Coastal Seas.
CTMP Effluent In the BioPAQ UASB System. W91-11501	W91-11444 5A	W91-10531 2L
PARIS-6 UNIV. (FRANCE), LAB, DE	PITTSBURGH UNIV., PA. GRADUATE	PUBLIC HEALTH LABORATORY SERVICE
PHYSIQUE ET CHIMIE MARINES.	SCHOOL OF PUBLIC HEALTH.  Distribution of Giardia Cysts in Wastewater.	CRYPTOSPORIDIUM REFERENCE UNIT, PUBLIC HEALTH LABORATORY, GLAN
Fluxes and Transport of Anthropogenic and Natural Polycyclic Aromatic Hydrocarbons in	W91-10649 5B	CLWYD HOSPITAL, BODELWYDDAN, RHYL, CLWYD, LL18 5UJ, WALES.
the Western Mediterranean Sea. W91-10841 5B	PLANT PROTECTION INST., SOFIA (BULGARIA).	Epidemiology of Human Cryptosporidiosis and the Water Route of Infection.
PARIS-7 UNIV. (FRANCE), LAB. DE	Determination of Herbicide Residues in Soil in	W91-10643 5B
PHYSICO-CHIMIE DE L'ATMOSPHERE.  Major Ions in Marine Rainwater With Attention	the Presence of Persistent Organochlorine Insecticides.	PUBLIC WORKS RESEARCH INST., TOKYO
to Sources of Alkaline and Acidic Species. W91-11250 5B	W91-11310 5A	(JAPAN).
	PLANTA PILOTO DE PROCESOS	Beneficial Utilization of Incinerated Ash and Melted Slag.
PATUXENT WILDLIFE RESEARCH CENTER, LAUREL, MD.	INDUSTRIALES MICROBIOLOGICOS, TUCUMAN (ARGENTINA).	W91-11154 5E
Atrazine Hazards to Fish, Wildlife, and Inverte- brates: A Synoptic Review.	Denitrification by Thermophilic Soil Bacteria	PUGET SOUND WATER QUALITY
W91-10709 5C	With Ethanol as Substrate in a USB Reactor. W91-11254 5D	AUTHORITY, SEATTLE, WA.  Environmental Management of the Puget
Subchronic Hepatotoxicity of Selenomethionine Ingestion in Mallard Ducks.	POLISH ACADEMY OF SCIENCES,	Sound.
W91-10838 5C	LOMIANKI. INST. EKOLOGII.  Can Fauna Impoverishment Affect Humus Con-	W91-10577 5G
PENNSYLVANIA STATE UNIV., UNIVERSITY	tent in Cultivated Soils (Czy ubozenie fauny moze wplywac na zawartosc prochnicy w gle-	PURDUE UNIV., LAFAYETTE, IN. DEPT. OF
PARK. DEPT. OF AGRICULTURAL ENGINEERING.	bach uprawnych).	AGRONOMY.
Agronomic Effects of Land Application of	W91-11543 2G	Diffusion in Fractal Porous Media. W91-11243 2F
Water Treatment Sludges. W91-11459 4C	POLLUTION CONTROL DEPARTMENT,	
PENNSYLVANIA STATE UNIV., UNIVERSITY	ARTOIS-PICARDY, FRANCE. Use of Municipal Sewage Sludge in Agriculture:	QUEBEC UNIV., MONTREAL. First-Order Organic Carbon Budget in the St
PARK. DEPT. OF AGRONOMY.	The Role of the Water Authorities.	Lawrence Lower Estuary from 13C Data.
Microbial Dechlorination of the Herbicide Me- tolachlor.	W91-11138 5D	W91-10498 2L
W91-11377 5B	PORT HARCOURT UNIV. (NIGERIA).  Proximate Composition and Nutrient Elements	QUEENSLAND DEPT. OF PRIMARY
PENNSYLVANIA STATE UNIV., UNIVERSITY	in the Unusual Algal Jellies of Lake Oguta in	INDUSTRIES, BRISBANE (AUSTRALIA). SOIL CONSERVATION RESEARCH
PARK. DEPT. OF CIVIL ENGINEERING. Self-Affine Scaling and Subsurface Response to	Southern Nigeria. W91-11408 2H	BRANCH.
Snowmelt in Steep Terrain. W91-10912 2G	PORT HARCOURT UNIV. (NIGERIA), DEPT,	Effect of Land Development on Groundwater Recharge Determined from Non-Steady Chlo-
Pre-hydrolyzed Aluminum Hydroxide and Iron	OF GEOLOGY.	ride Profiles. W91-10991 4C
Hydroxide in Activated Sludge Treatment. W91-11539 5D	Aquifers in the Benin Formation (Miocene- Recent), Eastern Niger Delta, Nigeria: Lithos-	W 91-10991
PENNSYLVANIA STATE UNIV., UNIVERSITY	tratigraphy, Hydraulics, and Water Quality. W91-11443 2F	QUEENSLAND UNIV., BRISBANE (AUSTRALIA). DEPT. OF CHEMICAL ENGINEERING.
PARK. DEPT. OF PLANT PATHOLOGY. Effects of Drought Stress and Simulated Acidic	PORT HARCOURT UNIV. (NIGERIA), DEPT.	Status of Eutrophication in the Great Barrier
Rain on Foliar Conductance of Zea mays L. W91-10919 5C	OF ZOOLOGY.  Hydrobiological Survey of the Chanomi Creek	Reef Lagoon. W91-10535 5B
PENNSYLVANIA STATE UNIV., UNIVERSITY	System, Lower Niger Delta, Nigeria. W91-11524 5C	
PARK. ENVIRONMENTAL RESOURCES	PRAIRIE PROVINCES WATER BOARD,	QUEENSLAND UNIV., BRISBANE (AUSTRALIA). DEPT. OF MICROBIOLOGY.
RESEARCH INST. Statistical Analysis of Errors in Estimating Wet Deposition Using Five Surface Estimation Algo-	REGINA (SASKATCHEWAN). Interprovincial Water Management in Western	Foaming in Activated Sludge Plants: A Survey in Queensland, Australia and an Evaluation of
rithms.	Canada.	Some Control Strategies.
W91-10474 7B	W91-11040 6E	W91-11328 5D

### SCHOOL OF AGRICULTURE, UNIVERSITY OF BOPHUTHATSWANA, SOUTH AFRICA.

(SOUTH AFRICA).	parison of Several Extrapolation Procedures.	PISCATAWAY, NJ. DEPT. OF CHEMICAL
Evaluation of Fecal Enterococci Isolation Media	W91-10830 5A	AND BIOCHEMICAL ENGINEERING.
to Indicate Fecal Pollution in Chlorinated		Migration and Treatment of a Dense Aqueous
Water. W91-10626 5F	Analysis of Halogenated Acetic Acids in Dutch	Contaminant Source and Plume.
W91-10020	Drinking Water. W91-10938 5F	W91-11380 3G
RAVISHANKAR UNIV., RAIPUR (INDIA).	W71-10550	RUTTE RECYCLING B,V., AMSTERDAM
DEPT. OF CHEMISTRY.	Application of HPLC Column-Switching in Pes-	(NETHERLANDS).
Simple Spectrophotometric Determination of	ticide Residue Analysis.	Processing Organic Waste Products to Black
Endosulfan in River Water and Soil. W91-11314 5A	W91-11308 5A	Soil and Organic Fertilizers.
W91-11314 3A	RIJKSINSTITUUT VOOR DE	W91-10705 5E
RDP, INC., WALTHAM, MA.	VOLKSGEZONDHEID EN MILIEUHYGIENE,	SAITAMA UNIV., URAWA (JAPAN). COLL,
Case Studies in Data Analysis.	BILTHOVEN (NETHERLANDS), LAB, FOR	OF LIBERAL ARTS,
W91-10733 2B	WATER AND FOOD MICROBIOLOGY.	Seasonal Changes of Organic Carbon and Nitro-
REACH/AGRISOURCE, CENEX/LAND	Production and Control of Reference Materials	gen Production by Phytoplankton in the Estuary
O'LAKES, PO BOX 64089, ST. PAUL, MN	for Water Microbiology. W91-10623 5A	of River Tamagawa.
55164-0089.	W91-10023	W91-10604 5B
AgriSource: The Information System for Crop	RIJKSINSTITUUT VOOR DE	SALFORD UNIV. (ENGLAND), DEPT. OF
Technology. W91-11196 10D	VOLKSGEZONDHEID EN MILIEUHYGIENE,	BIOLOGICAL SCIENCES.
W91-11196	BILTHOVEN (NETHERLANDS). LAB. OF	Use of Bacillus thuringiensis var. israelensis to
READING UNIV. (ENGLAND). DEPT. OF	WASTE MATERIALS AND EMISSIONS.	Control the Nuisance Fly Sylvicola fenestralis
MATHEMATICS.	Environmental Aspects of Landfilling Sludge. W91-11136 5E	(Anisopodidae) in Sewage Filter Beds.
Similarity Solutions of the Shallow Water Equa-		W91-10890 5D
tions.	RIJKSINSTITUUT VOOR ZUIVERING VAN	SAN FRANCISCO BAY CONSERVATION
W91-10987 8B	AFVALWATER, LELYSTAD	AND DEVELOPMENT COMMISSION, CA.
REGIONAL ENVIRONMENTAL CENTRE,	(NETHERLANDS).	Providing Access for the Public to the Shoreline
BUDAPEST (HUNGARY).	Influence of pH on Phosphate Release from Sediments.	of San Francisco Bay.
Socio-Political Aspects of the Bos-Nagymaros	W91-11327 2H	W91-10589 6E
Barrage System.		SAN FRANCISCO ESTUARY PROJECT, P.O.
W91-11217 6G	RIO DE JANEIRO BUREAU OF PUBLIC	BOX 2050, OAKLAND, CALIFORNIA.
RENNES-1 UNIV. (FRANCE), LAB. DE	WORKS (BRAZIL).	Environmental Activism in the San Francisco
MICROBIOLOGIE PHARMACEUTIQUE.	Analysis of a Sanitary-Embankment Failure Over the Rio de Janeiro Soft Clay Deposit.	Bay Estuary.
Salmonella Detection in Sewage Waters Using	W91-10780 8D	W91-10585 5G
Fluorescent Antibodies. W91-10687 5D	W/1-10/00	SAO PAULO UNIV. (BRAZIL), INST. DE
W91-10687 3D	ROBENS INST. OF INDUSTRIAL AND	BIOCIENCIAS.
RENSSELAER POLYTECHNIC INST., TROY,	ENVIRONMENTAL HEALTH AND SAFETY,	Oil Spills in Mangroves: A Conceptual Model
NY. RENSSELAER FRESH WATER INST.	GUILDFORD (ENGLAND).	Based on Long-term Field Observations.
Primary Productivity and Plankton Communi-	Effect of Heat Shock on Recovery of Escheri- chia coli from Drinking Water.	W91-10489 5B
ties in a Two-Reservoir Series. W91-10815 2H	W91-10628 5F	CAO DATE O IDEE OPATEL DIOT DE
W91-10813 2H		SAO PAULO UNIV. (BRAZIL). INST. DE CIENCIAS BIOMEDICAS.
RESOURCE SYSTEMS INST., HONOLULU,	ROBERT S. KERR ENVIRONMENTAL	Occurrence of V. cholerae 0:1 Non-Toxigenic in
HI.	RESEARCH LAB., ADA, OK.	Wastewaters from Sao Paulo, Brazil.
East Asian Seas: Hypothetical Oil Spill Trajec-	Stimulation of the Reductive Dechlorination of Tetrachloroethene in Anaerobic Aquifer Micro-	W91-10685 5D
tories. W91-10608 5B	cosms by the Addition of Toluene.	
W > 1-10000	W91-11344 5B	SAO PAULO UNIV., SAO CARLOS (BRAZIL). ESCOLA DE ENGENHARIA.
RHODE ISLAND UNIV., KINGSTON.		Perspectives for Ecological Modelling of Tropi-
GRADUATE SCHOOL OF OCEANOGRAPHY.	ROGERS, GOLDEN AND HALPERN, INC.,	cal and Subtropical Reservoirs in South Amer-
Voltammetric Determination of the Complexa-	PHILADELPHIA, PA. Interstate Cooperation in Dealing with Growth	ica.
tion Parameters of Zinc in Marine and Estuarine Waters.	Related Water Quality Impacts on the Chesa-	W91-10487 2H
W91-10924 2K	peake Bay.	CACHATCHERVAN INTO CACHATOON
	W91-11009 6E	SASKATCHEWAN UNIV., SASKATOON. DEPT. OF CIVIL ENGINEERING.
Measurement of the Different Forms of Zinc in	ROSTOCK UNIV. (GERMAN D.R.), DEPT. OF	Numerical Modelling of Vertical Ground Move-
Narragansett Bay Water Based on the Rate of Uptake by a Chelating Resin.	BIOLOGY.	ments in Expansive Soils.
W91-10926 2K	Saprobiological Investigations on the Bottom	W91-10945 2G
1171-10720	Flora of the River Recknitz in the Northern Part	CANADAM DUMB TAB ATPEN OF
RIJKSINSTITUUT VOOR DE	of the Mecklenburgian Lake District (GDR)	SAVANNAH RIVER LAB., AIKEN, SC. ENVIRONMENTAL SCIENCES DIV.
VOLKSGEZONDHEID, BILTHOVEN	(Saprobiologische Untersuchungen an der Benthosflora der Recknitz im Norden der Meck-	Comprehensive Cooling Water Study, Final
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Effectivity of Chlorine Dioxide to Control Aer-	W91-11520 2E	Effects.
omonas in Drinking Water Distribution Systems.		W91-10729 5B
W91-10677 5F	RUHR UNIV., BOCHUM (GERMANY, F.R.).	SCANVIRONMENT, ST ROR, S-386 00
TO 15 PM P . 1 1 M . 1 1 M	LEHRSTUHL FUER WASSERWIRTSCHAFT	FARJESTADEN, SWEDEN.
F-Specific RNA Bacteriophages as Model Vi- ruses in UV Disinfection of Wastewater.	UND UMWELTTECHNIK II.  Influences on the Mechanical Properties of	Conductivity for Nutrient Control In CTMP
W91-10682 5D	Sewage Studge for Disposal to Landfill.	Wastewater Treatment.
	W91-11135 5D	W91-11495 5D
RIJKSINSTITUUT VOOR DE		CONTROL OF ACIDICAL PROPERTY.
VOLKSGEZONDHEID EN MILIEUHYGIENE,	RUTGERS - THE STATE UNIV.,	SCHOOL OF AGRICULTURE, UNIVERSITY OF BOPHUTHATSWANA, SOUTH AFRICA.
BILTHOVEN (NETHERLANDS).  Virological Quality of Recreational Waters in	PISCATAWAY, NJ. Oil Transport Management and Marine Pollu-	Visual Interpretation of a Landsat Mosaic of the
the Netherlands.	tion Control: Oil Spill Prevention.	Okavango Delta and Surrounding Area.
W91-10653 5B	W91-11081 5G	W91-10879 2H

2H

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ic Hydrocarbons to Arctic Bottom Waters.	ulating Effluents from Pulp Mills.	quency Control.
W91-11340 5B	W91-11504 5G	W91-11214 8C
SCOTTISH PARASITE DIAGNOSTIC LAB.,	SPRINGBORN LABS., INC., WAREHAM, MA.	
GLASGOW.	Concentration of Metals in Various Larval	SUNDERLAND POLYTECHNIC (ENGLAND),
Occurrence of Cryptosporidium spp. Oocysts in	Stages of Four Ephemeroptera Species.	SCHOOL OF BIOLOGY.
Scottish Waters, and the Development of a	W91-11302 5B	Growth of Clinical Isolates of Astrovirus in a
Fluorogenic Viability Assay for Individual	SPRINGETTSBURY TOWNSHIP	Cell Line and the Preparation of Viral RNA.
Cryptosporidium Oocysts.	WASTEWATER TREATMENT FACILITY, PA.	W91-10669 5A
W91-10645 5B	Managing Toxic Substances in Municipal	COMPANY AND COMPANY COMPANY
Occurrence and Viability of Giardia spp. Cysts	Wastewater Treatment Plants.	SURREY UNIV., GUILDFORD (ENGLAND).
in UK Waters.	W91-11540 5D	DEPT. OF CIVIL ENGINEERING.
W91-10647 5B		Pressure of Clay Backfill against Retaining
***************************************	SRI KRISHNADEVARAYA UNIV.,	Structures.
SCRIPPS INSTITUTION OF	ANANTAPUR (INDIA), DEPT. OF ZOOLOGY.	W91-10947 8D
OCEANOGRAPHY, LA JOLLA, CA.	Assessment of Mercury Toxicity by the Changes	CHOOLEHANNA DIVED DACIN
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W91-10517 2B	W91-11304 5C	PROTECTION DIV.
ecuippe incrementor of		Nutrient Loading Status of the Conestoga River
SCRIPPS INSTITUTION OF	STANFORD UNIV., CA. DEPT. OF CIVIL	Basin, 1985-1989.
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tion.	inated Aliphatics: Part 1. Biostimulation of Methanotrophic Bacteria.	Source Discharge from Tile Drains, Spring and
W91-11412 2B	W91-10955 5G	Overland Runoff from Two Farms, Dauphin
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(ENGLAND).	BROOK, INST. FOR TERRESTRIAL AND	tivity Analysis.
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CHEETER TO THE COLOR AND DEED OF	W91-10971 2A	croporous Soil. II. Chloride Breakthrough
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ANIMAL AND PLANT SCIENCES. Effect of Coal-Mine Effluent on Fungal Assem-	BROOK, MARINE SCIENCES RESEARCH	W91-10804 2G
blages and Leaf Breakdown.	CENTER.	
W91-11320 5C	Assimilation of Metals in Marine Copepods and	SWEDISH ENVIRONMENTAL RESEARCH
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SHERBROOKE UNIV. (QUEBEC).	W91-10866 2L	Treatment of Bleach-Plant Effluents with Mem-
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W91-10946 2J	toms.	Mambana Filtration Combined with Dislocical
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TAKAMATSU (JAPAN).		fluents.
Construction of Artificial Seaweed Bed Accom-	STEARNS-ROGER ENGINEERING CO.,	W91-11490 5D
panied with the Reclamation for Unit No. 3 of	DENVER, CO.	W 31-11430 3D
Ikata Power Station.	Environmental Control Impacts of Selected Al-	Treatment Technologies for Organochlorine-
W91-10603 2L	ternate Fuels on Existing Power Plants. W91-11078 5G	Containing Sludges and Concentrates from Ex-
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SHIMANE PREFECTURAL INST. OF PUBLIC	STOCKHOLM UNIV. (SWEDEN), DEPT. OF	Wastewaters.
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SHIN NIPPON METOCEAN CONSULTANT	STOCKHOLM UNIV. (SWEDEN). DEPT. OF ZOOLOGY.	Drainage Systems.
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Tidal Flat: 1. Permeable Sandy Beach.	W91-10519 5C	Evidence for Dilution of Deep, Confined
W91-10541 5G		Ground Water by Vertical Recharge of Isotopi-
SOIL AND WATER LTD., HELSINKI	STUTTGART UNIV. (GERMANY, F.R.). INST.	cally Heavy Pleistocene Water.
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Recipients.	Models.	Groundwater Flow and the Metal Content of Peat.
W91-11509 5C	W91-10674 5B	W91-10902 2F
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Oxic Fluidized-Bed Treatment of Dichlorophen-	W91-10918 5C	TOKYO SEWERAGE BUREAU (JAPAN).
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TAMPERE WATER AND ENVIRONMENTAL	Selective Concentration of Lead(II) Chloride	W91-11153 5E
DISTRICT (FINLAND),	Complex With Liquid Anion-Exchange Mem- branes.	TOKYO UNIV. (JAPAN), DEPT. OF URBAN
Activated Sludge Treatment of Kraft Mill Ef- fluents from Conventional and Oxygen Bleach- ing.	W91-11247 5D	ENGINEERING.  Comparative Study on Adsorption Mechanisms of RNA-F-Specific Coliphages and Poliovirus in
W91-11511 5D	TEXAS UNIV. AT AUSTIN. DEPT. OF GEOLOGICAL SCIENCES.	Activated Sludge Process. W91-10694 5D
TECATOR A.B., HOGANAS (SWEDEN).  Determination of Trace Levels of Sulphate in	Fate of Silicate Minerals in a Peat Bog. W91-10789 2H	TORONTO UNIV. (ONTARIO), INST. FOR
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concentration. W91-11246 2K	(ENGLAND).  Isolation and Identification of Cryptosporidium	Great Lakes Water Levels Management: Relax- ing the 'Policy Trap'.
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tional Substrate. W91-11512 5D	Concentration. W91-10656 5A	France Lagoons. W91-10611 5G
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TECHNICAL UNIV. OF NOVA SCOTIA, HALIFAX. DEPT. OF CIVIL ENGINEERING.	(ENGLAND).	TRENT UNIV., PETERBOROUGH (ONTARIO), ENVIRONMENTAL AND
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TECHNION - ISRAEL INST. OF TECH.,	THE GROUP TO PROTECT THE TOGA	W91-11301 5C
HAIFA, FACULTY OF AGRICULTURAL ENGINEERING.	RIVER, 4-12, SHIKANOSHITA-DORI, 1 CHOME, NADA-KU, KOBE, 658 JAPAN.	TRENT UNIV., PETERBOROUGH
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TECHNION - ISRAEL INST. OF TECH.,	W91-10587 5G	W91-10904 2G
HAIFA, SHERMAN CENTER FOR RESEARCH IN ENVIRONMENTAL AND	THESSALONIKI UNIV., SALONIKA (GREECE), DEPT. OF GEOLOGY AND	Streamflow Generation in a Headwater Basin on
WATER RESOURCES ENGINEERING.	PHYSICAL GEOGRAPHY.	the Precambrian Shield.
Survival of Pathogenic Bacteria in an Adverse Environment.	Contribution to the Study of the Recession Curves of Karstic Springs: Examples from	W91-11349 2E
W91-10692 5D	Greece (Contribution a l'Etude des Courses de Recession des Sources Karstiques: Exemples du	TRENTO UNIV. (ITALY). DIPT. DI INGEGNERIA CIVILE E AMBIENTALE.
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FUER BOTANIK.	W91-10990 2F	W91-11232 2E
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TENNESSEE UNIV., KNOXVILLE, COLL. OF	Boundary Element and Particle Tracking Model	Water Rate Structure for Demand Managemen
VETERINARY MEDICINE,	for Advective Transport in Zoned Aquifers. W91-10997 2F	in the Regional Municipality of Waterloo.
Initial Evaluation of Developmental Malforma- tion as an End Point in Mixture Toxicity Hazard		W91-11049 60
Assessment for Aquatic Vertebrates. W91-10832 5C	TIERAERZTLICHE HOCHSCHULE HANNOVER (GERMANY, F.R.). INST. FUER	TSINGHUA UNIV., BEIJING (CHINA).
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Hydrogeochemical Processes Controlling Sub- surface Transport from an Upper Subcatchment	water Crayfish, Astacus astacus L. (Crustacea:	TUEBINGEN UNIV. (GERMANY, F.R.).
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Events. 1. Hydrologic Transport Processes. W91-10907 5B		and 'Index' Organisms. W91-10661 5/
Hydrogeochemical Processes Controlling Sub-	TOKUSHIMA UNIV. (JAPAN), DEPT. OF INFORMATION SCIENCE AND	
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W91-10908 5B	W91-10581 7B	W91-10666 5/

TUEBINGEN UNIV. (GERMANY, F.R.). HYGIEN	E INST.	
Behaviour of Pathogenic Bacteria, Phages and Viruses in Groundwater During Transport and Adsorption.	UNIVERSITAT DE LES ILLES BALEARS, PALMA DE MALLORCA (SPAIN). INST. D'ESTUDIS AVANCATS.	UNIVERSITY OF WESTERN ONTARIO, LONDON, DEPT. OF CIVIL ENGINEERING, Electroosmotic Strengthening of Soft Sensitive
W91-10672 5B	Mercury Body Burden and Otolith Characteris- tics of Bluefin Tuna from the Northwest Medi-	Clays. W91-10777 8D
Field Experiments with Microbiological Tracers in a Pore Aquifer.	terranean (Balearic Sea). W91-10881 2L	Field Test of Electroosmotic Strengthening of
W91-10673 5B	UNIVERSITE DE BRETAGNE-	Soft Sensitive Clay.
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on Irrigated Farms in Saskatchewan. W91-11054 6C	hydrate-Like Substances) in an Estuarine Envi-	UNIVERSITY OF WESTERN ONTARIO, LONDON, DEPT. OF GEOGRAPHY.
UNITED NATIONS ENVIRONMENT	W91-10840 2L	Changing Dynamics of Interest Representation in Water Resources Management.
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Plan. W91-10574 5G	Japanese Knotweed (Reynoutria japonica Houtt).	Analysis of Three-Dimensional Ground Move- ments: The Thunder Bay Tunnel.
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Basin. W91-11403 5C	UNIVERSITY COLL., GALWAY (IRELAND), DEPT. OF EXPERIMENTAL PHYSICS,	Determination of Selenium Species in Spent Oil Shale Leachates by Ion Chromatography.
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INGENIEROS DE CAMINOS, CANALES Y PUERTOS.	W91-10973 2B	W91-10901 5C
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VALENCIA (SPAIN). INST. OF HYDROLOGY AND ENVIRONMENT.	W91-11249 5B	an Artificial Lake Using a Mesoscale Model. W91-10502 2B
Enumeration of Motile Aeromonas in Valencia Coastal Waters by Membrane Filtration. W91-10636 5B	UNIVERSITY OF NEW ENGLAND, ARMIDALE (AUSTRALIA). CENTRE FOR WATER POLICY RESEARCH.	UPSTATE FRESHWATER INST., INC.,
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ZENTRUM FUER UMWELTFORSCHUNG, ANGEWANDTE MIKROBIOLOGIE UND HYGIENE.	DEPT. OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH. Use of Risk Assessment for Development of	UTAH STATE UNIV., LOGAN, DEPT. OF
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South Limburg (The Netherlands) and the Influ- ence of Chernobyl Fallout.	Scheldt Estuary, Belgium.	Reactor Study Comparison.
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	WAHNBACHTALSPERRENVERBAND,	Method.
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With Aid of Crossflow Microfiltration.	Flocculation of Micro-organisms. W91-11267 5F	WATER AUTHORITY, GEORGE TOWN
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Carbaryl.	W91-11386 6E	New Developments in Sampling Sludge Treated
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the Lake Levels Study.	ATMOSPHERIC SCIENCES.  Research on Clouds and Precipitation: Past,	tural.
W91-11037 6A	Present and Future, Part II.	W91-11120 51
VIRGINIA POLYTECHNIC INST. AND STATE	W91-10481 3B	
UNIV., BLACKSBURG. DEPT. OF FISHERIES	Satellite-Derived Integrated Water-Vapor Dis-	WATER SCIENCE, BOULDER, CO. Fate and Transport of Sediment-Associates
AND WILDLIFE SCIENCES.	tribution in Oceanic Midlatitude Storms: Varia-	Contaminants.
Assessing Stream Values: Perspectives of Aquat- ic Resource Professionals.	tion with Region and Season.	W91-11587 51
W91-11425 8I	W91-11419 2B	
Habitat Use by an Assemblage of Fish in a Large	WASHINGTON UNIV., SEATTLE, DEPT. OF	WATERLOO UNIV. (ONTARIO). INST. FOR GROUND WATER RESEARCH.
Warmwater Stream.	CIVIL ENGINEERING.	Depth of Fractures and Active Ground-Wate
W91-11533 2H	Investigation of Anaerobic Removal and Degra- dation of Organic Chlorine from Kraft Bleach-	Flow in a Clayey Till Plain in Southwestern
VIRGINIA UNIV., CHARLOTTESVILLE.	ing Wastewaters.	Ontario.
Acid-Base Status of Pennsylvania Streams: Re-	W91-11492 5D	W91-10959 21
sults from the National Stream Survey.	Interpretation of Hydrologic Effects of Climate	WATERLOOPKUNDIG LAB, TE DELFT
W91-10726 5B	Change in the Sacramento-San Joaquin River	(NETHERLANDS).
VIRGINIA UNIV., CHARLOTTESVILLE.	Basin, California.	In-Flow Vibrations of Gate Edges.
DEPT. OF ENVIRONMENTAL SCIENCES.	W91-11552 5C	W91-10724 81
Throughflow and Solute Transport in an Isolat- ed Sloping Soil Block in a Forested Catchment.	WASSERWIRTSCHAFT STADE (GERMANY,	Investigation of Local Scaus in Cohericals
W91-10993 2G	F.R.).	Investigation of Local Scour in Cohesionles Sediments Using a Tunnel-Model.
WZCAZDAI KODACI ZUDOMANIKOS	Sludge Reduction Possibilities as Demonstrated by the Chemolysis Process Dow Stade GmbH.	W91-10746 2
VIZGAZDALKODASI TUDOMANYOS KUTATO INTEZET, BUDAPEST (HUNGARY).	W91-11118 5D	
Flood Forecasts on Transboundary Rivers in		Rocking Armour Units: Number, Location an
Hungary with Parallels in Canada. W91-11015 4A	Chemolysis Process of Dow Stade GMBH. W91-11144 5D	Impact Velocity. W91-10786
W91-11015 4A	11/11/11	

## WEISS ASSOCIATES, OAKLAND, CA.

WEISS ASSOCIATES, OAKLAND, CA.	WISCONSIN DEPT. OF NATURAL	WROCLAW UNIV. (POLAND). INST.
Soil Vapor Survey at the LLNL Site 300 Gener-	RESOURCES, MADISON, BUREAU OF FISH	GEOGRAFICZNY.
al Services Area, Adjacent Portions of the Con-	MANAGEMENT.	Studies of Springs in the Southern Part of the
nolly and Gallo Ranches and the Site 300 Land- fill Pit 6 Area.	Review of Fisheries Habitat Improvement Projects in Warmwater Streams, with Recom-	Valley of Mexico (Estudio Crenologico en la Parte Meridional de la Cuenca de Mexico).
W91-10747 5B	mendations for Wisconsin. W91-11591 2H	W91-11352 2E
WEST VIRGINIA UNIV., MORGANTOWN.		WUERZBURG UNIV. (GERMANY, F.R.).
DEPT. OF MECHANICAL AND AEROSPACE	WISCONSIN DIV. OF HEALTH, MADISON.	INST. FUER GENETIK UND
ENGINEERING.	SECTION OF ENVIRONMENTAL AND CHRONIC DISEASE EPIDEMIOLOGY.	MIKROBIOLOGIE.
Design of Economic and Efficient Treatment	Wisconsin's Risk Assessment Based Numerical	
Station for Acidic Streams.	Groundwater Standards Program.	Pulsed Field Electrophoresis of Genomic Re striction Fragments for the Detection of Noso
W91-11077 5G	W91-11183 5G	comial Legionella pneumophila in Hospita
		Water Supplies.
WESTERN AUSTRALIA MINISTRY FOR THE	WISCONSIN GEOLOGICAL AND NATURAL	W91-10836 5A
ENVIRONMENT, PERTH.	HISTORY SURVEY, MADISON.	W 91-10030
Management of the Marine Environment in	Tritium as an Indicator of Ground-Water Age in	YALE UNIV., NEW HAVEN, CT. DEPT. OF
Western Australia: An Ecosystem Approach.	Central Wisconsin. W91-10958 2F	ECONOMICS.
W91-10583 5G	W 91-10936 2F	
	WISCONSIN UNIVMADISON, DEPT, OF	Uncertainty in the Projection of Carbon Dioxid
WESTERN AUSTRALIA UNIV., NEDLANDS,	GEOLOGY AND GEOPHYSICS.	Emissions.
CENTRE FOR WATER RESEARCH.	Geochemical Evolution in the Cambrian-Ordo-	W91-11069 51
Macroalgal-Sediment Nutrient Interactions and	vician Sandstone Aquifer, Eastern Wisconsin: 1.	
Their Importance to Macroalgal Nutrition in a	Major Ion and Radionuclide Distribution.	YAMAGUCHI PREFECTURAL RESEARCH
Eutrophic Estuary.	W91-10953 2K	INST. OF HEALTH (JAPAN).
W91-10497 2L	WISCONSIN UNIV, MADISON, DEPT, OF	Eutrophication Mechanisms of Coastal Seas is
	SOIL SCIENCE.	Yamaguchi Prefecture.
WESTERN AUSTRALIA UNIV., NEDLANDS.	Method for Installing Miniature Multilevel Sam-	W91-10593 51
DEPT. OF ZOOLOGY.	pling Wells.	
Use of the Intertidal Zone by Fish in Nova	W91-10962 5A	YAMAGUCHI UNIV. (JAPAN). DEPT. OF
Scotia.		CIVIL ENGINEERING.
W91-11557 2L	Agrichemicals and Ground Water: Assumptions about Farmer Information Processes.	Evaluation of Primary Production Loads an Their Control in Enclosed Seas.
WESTERN AUSTRALIA UNIV., NEDLANDS.	W91-11163 6B	W91-10524 50
FACULTY OF LAW.		W 91-10324
Legislative Implementation of Integrated Catch-	WISCONSIN UNIVMILWAUKEE. DEPT. OF	YORKSHIRE WATER AUTHORITY
ment Management in Western Australia.	CIVIL ENGINEERING.	(ENGLAND).
W91-11374 6E	Recent Sedimentation in Lake Michigan. W91-10976	Comparison of Alternative Operating Modes of
	W 91-10970	the Halifax Activated-Sludge Plant.
WESTINGHOUSE HANFORD CO.,	Polychlorinated Biphenyls in Dated Sediment	
RICHLAND, WA.	Cores from Green Bay and Lake Michigan.	W91-11339
Fiscal Year 1988 Supported Liquid Membrane	W91-10979 5B	ZAGREB UNIV. (YUGOSLAVIA), FACULTY
Development Report.		OF CIVIL ENGINEERING.
W91-10727 5G	WITHINGTON UNIV. HOSPITAL,	Assessment of the Environmental Capacity of
	MANCHESTER (ENGLAND).  Latex Agglutination for the Detection of Cam-	
Status of Ground Water in the 1100 Area.	pylobacter Species in Water.	W91-10571 55
W91-10732 5B	W91-11465 5A	W91-105/1
		ZHEJIANG AGRICULTURAL UNIV.,
WESTON SERVICES, INC., WEST CHESTER,	WITTEVEEN AND BOS, DEVENTER	HANGZHOU (CHINA), DEPT, OF PLANT
PA.	(NETHERLANDS).	PROTECTION
Evaluation of Full Scale Activated Sludge Sys-	Sludge Studies on Sludge Management: Strate	Behavior of the Fungicide MBAMT in Wate
tems Utilizing Powdered Activated Carbon Ad-	gic Studies on Sludge. W91-11156 5D	
dition with Wet Air Regeneration.	W91-11150	W91-11315 5.
W91-11099 5D	WORLD HEALTH ORGANIZATION,	TUDICII IDIN VII CUIDEDC
	GENEVA (SWITZERLAND), DIV. OF	ZURICH UNIV., KILCHBERG (SWIZERLAND), HYDROBIOLOGICAL-
WINDSOR UNIV. (ONTARIO). GREAT LAKES	ENVIRONMENTAL HEALTH.	LIMNOLOGICAL STATION
INST.	Public Health Criteria for the Aquatic Environ-	D:10 01:00 011:0:
Disconnection of Chloriest A	many December WILLO Could live and Their April	Diei Oxygen Cycle in Three Subalbine Swi
Bioconcentration of Chlorinated Aromatic Hy-	ment: Recent WHO Guidelines and Their Appli-	
Bioconcentration of Chlorinated Aromatic Hy- drocarbons in Aquatic Macrophytes. W91-11338 5B	cation. W91-10620 50	Streams.

# ACCESSION NUMBER INDEX

W91-10469	5A	W91-10553 2H	W91-10637	5B	W91-10721	5G
W91-10470	7C	W91-10554 5C		5B	W91-10722	8B
	5B		W91-10639	5A		8C
W91-10471					W91-10723	
W91-10472	2B	W91-10556 5C	W91-10640	5A	W91-10724	8B
W91-10473	5G	W91-10557 5C	W91-10641	5B	W91-10725	5C
W91-10474	7B	W91-10558 5B	W91-10642	5B	W91-10726	5B
W91-10475	2B	W91-10559 5C	W91-10643	5B	W91-10727	5G
W91-10476	5B	W91-10560 5C	W91-10644	5A	W91-10728	2B
W91-10477	5G	W91-10561 6G	W91-10645	5B		
					W91-10729	5B
W91-10478	5B	W91-10562 6G	W91-10646	5A	W91-10730	5G
W91-10479	2B	W91-10563 4C	W91-10647	5B	W91-10731	5B
W91-10480	2H	W91-10564 6G	W91-10648	5B	W91-10732	5B
W91-10481	3B	W91-10565 2L	W91-10649	5B	W91-10733	2B
W91-10482	5F	W91-10566 6G	W91-10650	5B		
W91-10483	5G	W91-10567 5G	W91-10651	5B	W91-10734	8F
					W91-10735	5G
W91-10484	5G	W91-10568 5G	W91-10652	5B	W91-10736	2F
W91-10485	5D	W91-10569 5B	W91-10653	5B	W91-10737	5D
W91-10486	5G	W91-10570 5E	W91-10654	5F	W91-10738	5B
W91-10487	2H	W91-10571 5E	W91-10655	5A	W91-10739	
W91-10488	5B	W91-10572 5G	W91-10656	5A		5B
W91-10489	5B	W91-10573 5G	W91-10657	5A	W91-10740	5E
					W91-10741	5C
W91-10490	5G	W91-10574 5G	W91-10658	5A	W91-10742	5B
W91-10491	5C	W91-10575 5G	W91-10659	5A	W91-10743	5G
W91-10492	2H	W91-10576 2L	W91-10660	5A	W91-10744	5D
W91-10493	8A	W91-10577 5G	W91-10661	5A		
W91-10494	2L	W91-10578 5G	W91-10662	5B	W91-10745	5B
W91-10495	2L	W91-10579 5G	W91-10663	5A	W91-10746	2J
		W91-10580 5G	W91-10664	5A	W91-10747	5B
W91-10496	2L				W91-10748	5G
W91-10497	2L	W91-10581 7B	W91-10665	5A	W91-10749	5G
W91-10498	2L	W91-10582 5G	W91-10666	5A		
W91-10499	2B	W91-10583 5G	W91-10667	5A	W91-10750	5G
W91-10500	2B	W91-10584 5G	W91-10668	5A	W91-10751	5F
W91-10501	2E	W91-10585 5G	W91-10669	5A	W91-10752	3C
			W91-10670	5A	W91-10753	5B
W91-10502	2B				W91-10754	8F
W91-10503	5F	W91-10587 5G	W91-10671	5B		
W91-10504	5C	W91-10588 5G	W91-10672	5B	W91-10755	5G
W91-10505	6B	W91-10589 6E	W91-10673	5B	W91-10756	5G
W91-10506	6B	W91-10590 5G	W91-10674	5B	W91-10757	5C
W91-10507	5G	W91-10591 3F	W91-10675	5B	W91-10758	5G
W91-10508		W91-10592 5B	W91-10676	5B	W91-10759	5G
	2L				W91-10760	
W91-10509	2.J	W91-10593 5B	W91-10677	5F	W91-10761	4C
W91-10510	2J	W91-10594 5E	W91-10678	5F		
W91-10511	2.5	W91-10595 2L	W91-10679	5F	W91-10762	
W91-10512	2.J	W91-10596 5G	W91-10680	5F	W91-10763	
W91-10513		W91-10597 5B	W91-10681	5D	W91-10764	7C
W91-10514		W91-10598 5G	W91-10682	5D	W91-10765	4A
				5D	W91-10766	
W91-10515		W91-10599 2L	W91-10683			
W91-10516	2C	W91-10600 5B	W91-10684	5F	W91-10767	
W91-10517	2B	W91-10601 5D	W91-10685	5D	W91-10768	
W91-10518	5C	W91-10602 5A	W91-10686	5D	W91-10769	5B
W91-10519		W91-10603 2L	W91-10687	5D	W91-10770	2E
W91-10520		W91-10604 5B	W91-10688	5D	W91-10771	4C
			W91-10689	5D	W91-10772	
W91-10521		W91-10605 5B				
W91-10522	5B	W91-10606 2L	W91-10690	5D	W91-10773	
W91-10523	5G	W91-10607 2L	W91-10691	5D	W91-10774	
W91-10524	5G	W91-10608 5B	W91-10692	5D	W91-10775	8A
W91-10525		W91-10609 7C	W91-10693	5E	W91-10776	8D
		W91-10610 2L	W91-10694	5D	W91-10777	
W91-10526			W91-10695	5A	W91-10778	
W91-10527		W91-10611 5G			W91-10779	
W91-10528		W91-10612 5F	W91-10696	5A		
W91-10529	5C	W91-10613 5A	W91-10697	5A	W91-10780	
W91-10530		W91-10614 5F	W91-10698	5A	W91-10781	
W91-10531		W91-10615 5C	W91-10699	5D	W91-10782	2 8G
		W91-10616 5B	W91-10700	5D	W91-10783	
W91-10532				5D	W91-10784	
W91-10533		W91-10617 5C	W91-10701			
W91-10534		W91-10618 5B	W91-10702	5D	W91-10785	
W91-10535	5 5B	W91-10619 5G	W91-10703	5D	W91-10786	
W91-10536		W91-10620 5G	W91-10704	5D	W91-10787	
W91-10537		W91-10621 5F	W91-10705	5E	W91-10788	8 2B
		W91-10622 5A	W91-10706		W91-10789	
W91-10538			W91-10707		W91-10790	
W91-10539		W91-10623 5A				
W91-10540	5B	W91-10624 5G	W91-10708		W91-10791	
W91-10541		W91-10625 5G	W91-10709		W91-10792	
W91-10542		W91-10626 5F	W91-10710	5B	W91-10793	
		W91-10627 5F	W91-10711	5G	W91-10794	4 5A
W91-10543			W91-10712		W91-1079	
W91-10544		W91-10628 5F				
W91-10545		W91-10629 5A	W91-10713		W91-1079	
W91-10546	6 5B	W91-10630 5F	W91-10714		W91-1079	
W91-1054		W91-10631 5B	W91-10715	5G	W91-1079	
W91-1054		W91-10632 5B	W91-10716	5G	W91-1079	9 5G
			W91-10717		W91-1080	
W91-10549		W91-10633 5B			W91-1080	
W91-1055		W91-10634 5D	W91-10718			
W91-1055	1 5B	W91-10635 5A	W91-10719		W91-1080	
W91-1055		W91-10636 5B	W91-10720	7B	W91-1080	3 5B

### W91-10804

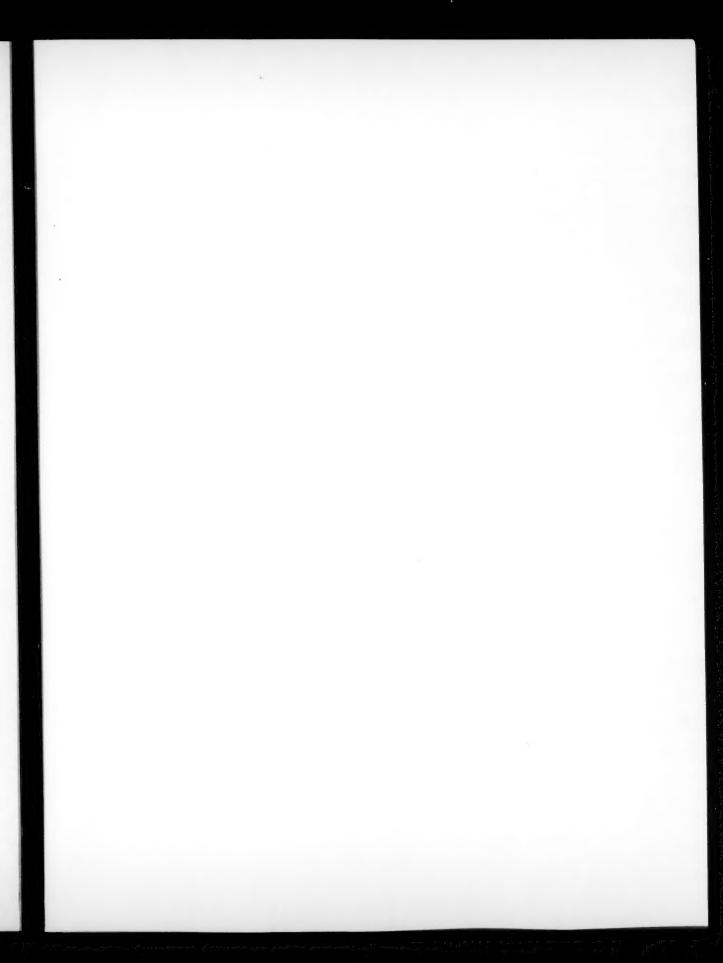
					2201 11027 CG
	2G		2K	W91-10972 2I	W91-11056 6C
W91-10805	3F	W91-10889	SD	W91-10973 2B	W91-11057 5G
W91-10806	3F	W91-10890	SD	W91-10974 2H	W91-11058 6G
W91-10807	6D		SC .	W91-10975 2H	
W91-10808	5G		7B	W91-10976 2J	W91-11060 5C
W91-10809	2E	W91-10893	5A	W91-10977 5C	W91-11061 5C
W91-10810	2B	W91-10894	5A	W91-10978 2H	W91-11062 5B
W91-10811	6D		2H	W91-10979 5B	W91-11063 5G
W91-10812	2E	W91-10896	2H	W91-10980 2H	W91-11064 5B
W91-10813	7B		5C	W91-10981 2J	
				W91-10982 5B	
W91-10814	3D		2H		W91-11066 5B
W91-10815	2H	W91-10899	2H	W91-10983 5F	W91-11067 5C
W91-10816	5G	W91-10900	5C	W91-10984 8B	
W91-10817	6E		5C	W91-10985 8B	
					W91-11069 5B
W91-10818	2.5		2F	W91-10986 5E	W91-11070 7C
W91-10819	2H	W91-10903	5B	W91-10987 8B	W91-11071 2K
W91-10820	2G	W91-10904	2G	W91-10988 7B	
					W91-11072 4C
W91-10821	3F		21		W91-11073 5C
W91-10822	2F	W91-10906	2G	W91-10990 2F	W91-11074 5B
W91-10823	5A	W91-10907	5B	W91-10991 4C	
W91-10824	5A		5B	W91-10992 2H	W91-11075 5B
					W91-11076 5C
W91-10825	5C		5B	W91-10993 2G	W91-11077 5G
W91-10826	5C	W91-10910	2F	W91-10994 2F	
W91-10827	5B		4B	W91-10995 2I	W91-11078 5G
					W91-11079 5G
W91-10828	5A		2G	W91-10996 5E	W91-11080 5G
W91-10829	5C	W91-10913	2G	W91-10997 2F	
W91-10830	5A	W91-10914	2G	W91-10998 2F	W91-11081 5G
W91-10831	5B	W91-10915	2G	W91-10999 5B	W91-11082 5C
					W01 11002 KD
W91-10832	5C	W91-10916	2G	W91-11000 5D	
W91-10833	5C	W91-10917	2G	W91-11001 5B	W91-11084 5A
W91-10834	8I	W91-10918	5C	W91-11002 2B	W91-11085 5B
					W91-11086 2F
W91-10835	5C	W91-10919	5C	W91-11003 6E	WING 4100# AT
W91-10836	5A	W91-10920	5A	W91-11004 6E	W91-11087 2F
W91-10837	5C	W91-10921	5F	W91-11005 6A	W91-11088 2F
	5C		5B		
W91-10838		W91-10922			
W91-10839	5B	W91-10923	5B	W91-11007 6E	
W91-10840	2L	W91-10924	2K	W91-11008 6E	W91-11091 2F
W91-10841	5B	W91-10925	5B	W91-11009 6E	
W91-10842	5D	W91-10926	2K	W91-11010 6E	
W91-10843	5B	W91-10927	5B	W91-11011 6E	W91-11094 5B
W91-10844	4C	W91-10928	5D	W91-11012 6A	
					******
W91-10845	5D	W91-10929	5B	W91-11013 6E	
W91-10846	2K	W91-10930	5C	W91-11014 2E	W91-11097 7B
W91-10847	2J	W91-10931	2H	W91-11015 4A	W91-11098 6E
W91-10848	4A	W91-10932	5D	W91-11016 5E	
W91-10849	5B	W91-10933	5C	W91-11017 5F	W91-11100 2F
W91-10850	6E	W91-10934	5B	W91-11018 6E	W91-11101 5B
W91-10851	5B	W91-10935	5B	W91-11019 6E	
W91-10852	4A	W91-10936	5B	W91-11020 2E	W91-11103 5B
W91-10853	2L	W91-10937	5D	W91-11021 40	W91-11104 2F
W91-10854	2L	W91-10938	5F	W91-11022 2F	
W91-10855	2H	W91-10939	5D	W91-11023 2F	H W91-11106 4B
W91-10856	2H	W91-10940	5C	W91-11024 6F	W91-11107 2E
W91-10857	2B	W91-10941	5F	W91-11025 6/	
W91-10858	2B	W91-10942	8F	W91-11026 6I	
W91-10859	2H	W91-10943	2B	W91-11027 6A	W91-11110 7B
W91-10860		W91-10944	2J	W91-11028 6/	
W91-10861	2H	W91-10945	2G	W91-11029 70	
W91-10862	2H	W91-10946	2.3	W91-11030 6/	
W91-10863	2H	W91-10947	8D	W91-11031 6/	W91-11114 2F
W91-10864	2H	W91-10948	8D	W91-11032 6/	
W91-10865	2L	W91-10949	8E	W91-11033 6	
W91-10866	2L	W91-10950	5B	W91-11034 6	E W91-11117 5E
W91-10867	2L	W91-10951	5B	W91-11035 6/	
W91-10868		W91-10952	5B	W91-11036 6	
W91-10869	5C	W91-10953	2K	W91-11037 6	A W91-11120 5E
W91-10870		W91-10954	2F	W91-11038 61	
W91-10871		W91-10955		W91-11039 6	
W91-10872	5B	W91-10956	7B	W91-11040 6	
W91-10873	5B	W91-10957	2F	W91-11041 6	D W91-11124 5I
W91-10874		W91-10958		W91-11042 6	
W91-10875		W91-10959		W91-11043 6	
W91-10876	5B	W91-10960	5B	W91-11044 6	C W91-11127 5I
W91-10877				W91-11045 6	
		W91-10961			
W91-10878	3 2I	W91-10962	5A	W91-11046 6	
W91-10879	2H	W91-10963	2A	W91-11047 6	C W91-11130 5E
W91-10880		W91-10964		W91-11048 6	
W91-10881		W91-10965		W91-11049 6	
W91-10882	5B	W91-10966	2E	W91-11050 3	F W91-11133 5I
W91-10883		W91-10967		W91-11051 6	
W91-10884		W91-10968		W91-11052 3	
W91-10885	5 5B	W91-10969	2B	W91-11053 4	C W91-11136 5E
W91-10886		W91-10970		W91-11054 6	
W91-10887	5B	W91-10971	2A	W91-11055 6	D W91-11138 5I

W91-11139	5D	W91-11223 5D	W91-11307 5A	W91-11391 2C
W91-11140	5D	W91-11224 5D		
W91-11141	5D	W91-11225 5F	THIO 11200 CA	WID1 11100
			W91-11308 5A W91-11309 5A W91-11310 5A	W91-11393 7C
W91-11142	5D	W91-11226 6A W91-11227 5B	W91-11310 3A	W91-11394 2C
W91-11143	5D		W91-11311 5A W91-11312 5A	W91-11395 2D
W91-11144	5D	W91-11228 5B W91-11229 5B	W91-11312 5A W91-11313 5A W91-11314 5A W91-11315 5A W91-11317 5G W91-11318 5D W91-11319 5D	W91-11396 2E
W91-11145	5D		W91-11313 5A	W91-11397 2H
W91-11146	5D	W91-11230 2B	W91-11314 5A	W91-11398 2K
W91-11147	5D	W91-11231 2J W91-11232 2E	W91-11315 5A	W91-11399 7C
W91-11148	5E	W91-11232 2E	W91-11316 5D	W91-11400 2L
W91-11149	5E	W91-11233 5C W91-11234 2F	W91-11317 5G	W91-11401 2H
W91-11150	5E 5E 5E	W91-11234 2F	W91-11318 5D	W91-11402 2H
W91-11151	5E	W91-11235 5G W91-11236 2F	W91-11319 5D	W91-11403 5C
W91-11152	5E	W91-11236 2F	W91-11320 5C	W91-11404 5C
W91-11153	5E	W91-11237 2G	W91-11321 5D	W91-11405 2H
W91-11154	5E	W91-11237 2G W91-11238 5G W91-11239 5B	W91-11322 5B	W91-11406 5C
W91-11155	5D	W91-11239 5B	W91-11323 5D	W91-11407 2H
W91-11156	5D	W91-11240 2F	W91-11324 5B	W91-11407 2H
W91-11157	5E	W91-11241 5B	W91-11325 5B	
W91-11158	5A	W91-11242 5B	W91-11326 5D	W91-11409 2B
W91-11159	5A	W91-11243 2F	W91-11327 2H	W91-11410 2B
W91-11160	5E	W91-11243 2F W91-11244 2D	W91-11328 5D	W91-11411 2B
W91-11161	5E	W91-11245 5A	W91-11329 5A	W91-11412 2B
W91-11162	5G	W91-11246 2K	W91-11330 5G	W91-11413 2G
W91-11163	6B	W91-11247 5D	W91-11331 5A	W91-11414 2B
W91-11164	5G	W91-11248 5B	W91-11332 5C	W91-11415 2B
W91-11165	5G	W91-11249 5B	W91-11333 2H	W91-11416 2B
W91-11166	10D	W91-11250 5B	W91-11334 5A	W91-11417 2B
	2F	W91-11251 5B	W91-11335 5B	W91-11418 2B
W91-11167	5D 5D 5E 5A 5A 5E 5E 5G 6B 5G 10D 2F 5B	W91-11251 3B W91-11252 2B		W91-11419 2B
W91-11168				W91-11420 2B
W91-11169	3F	W91-11253 2B		W91-11421 2B
W91-11170	6E	W91-11254 5D	W91-11338 5B	W91-11422 2B
W91-11171	6E	W91-11255 5A	W91-11339 2H	W91-11423 2B
W91-11172	5G	W91-11256 5A	W91-11340 5B	W91-11424 2B
W91-11173	5D	W91-11257 5A	W91-11341 5B	
W91-11174	7C	W91-11258 2L	W91-11342 5B	W91-11425 8I
W91-11175	7C	W91-11259 5A	W91-11343 5B	W91-11426 5C
W91-11176	7C	W91-11260 5A	W91-11344 5B	W91-11427 5C
W91-11177	5G	W91-11261 5A	W91-11345 2D	W91-11428 7B
W91-11178	5B	W91-11262 5A	W91-11346 2D	W91-11429 2A
W91-11179	5G	W91-11263 6G	W91-11347 2G	W91-11430 2G
W91-11180	6C	W91-11264 5A	W91-11348 2C	W91-11431 8B
W91-11181	5G	W91-11265 2J	W91-11349 2E	W91-11432 5G
W91-11182	5G	W91-11266 7C	W91-11350 7B	W91-11433 2G
W91-11183	5G	W91-11267 5F	W91-11351 7B	W91-11434 3C
W91-11184	5G	W91-11268 5F	W91-11352 2E	W91-11435 3F
W91-11185	6B	W91-11269 5F	W91-11353 7C	W91-11436 3F
W91-11186	5G	W91-11270 5F	W91-11354 7C	W91-11437 5G
W91-11187		W91-11271 5F	W91-11355 5D	W91-11438 2K
W91-11188	5G	W91-11272 5F	W91-11356 5B	W91-11439 5G
W91-11189		W91-11273 7C	W91-11357 5D	W91-11440 6E
W91-11190		W91-11274 8C	W91-11358 6B	W91-11441 6G
W91-11191		W91-11275 4A	W91-11359 5D	W91-11442 6G
W91-11192		W91-11276 8C	W91-11360 5D	W91-11443 2F
W91-11193		W91-11277 5D	W91-11361 5D	W91-11444 5A
W91-11194		W91-11278 7A	W91-11362 6G	W91-11445 5B
W91-11195		W91-11279 8I	W91-11363 4C	W91-11446 2F
W91-11196		W91-11280 5E	W91-11364 4C	W91-11447 5G
W91-11190		W91-11280 3E W91-11281 2E	W91-11365 8A	W91-11448 2J
		W91-11281 2E W91-11282 2E	W91-11366 5C	W91-11449 2I
W91-11198		W91-11282 2E W91-11283 5G	W91-11366 3C W91-11367 5D	W91-11450 2H
W91-11199				W91-11451 2E
W91-11200		W91-11284 8A	W91-11368 5F	
W91-11201		W91-11285 5E	W91-11369 5D W91-11370 5G	W91-11452 2H W91-11453 5B
W91-11202		W91-11286 8A	1.00	
W91-11203		W91-11287 8C	W91-11371 5D	W91-11454 5B
W91-11204		W91-11288 6D	W91-11372 5D	W91-11455 5D
W91-11205		W91-11289 6G	W91-11373 6G	W91-11456 5C
W91-11206		W91-11290 8C	W91-11374 6E	W91-11457 5C
W91-11207		W91-11291 8A	W91-11375 5B	W91-11458 5C
W91-11208		W91-11292 5B	W91-11376 5B	W91-11459 4C
W91-11209	9 4A	W91-11293 2A	W91-11377 5B	W91-11460 6D
W91-11210	) 4A	W91-11294 8C	W91-11378 5B	W91-11461 5B
W91-11211	5F	W91-11295 5A	W91-11379 5A	W91-11462 5F
W91-11212		W91-11296 5A	W91-11380 5G	W91-11463 5A
W91-11213		W91-11297 2K	W91-11381 5D	W91-11464 5B
W91-11214		W91-11298 5B	W91-11382 4B	W91-11465 5A
W91-1121		W91-11299 5B	W91-11383 6E	W91-11466 5D
W91-1121		W91-11300 5A	W91-11384 6E	W91-11467 5D
W91-1121		W91-11301 5C	W91-11385 6B	W91-11468 5G
W91-1121		W91-11302 5B	W91-11386 6E	W91-11469 5G
			W91-11387 5G	W91-11470 5G
W91-11219		W91-11303 5C W91-11304 5C	W91-11388 6E	W91-11471 5G
W91-11220			W91-11389 7B	W91-11472 5G
W91-1122		W91-11305 5A	W91-11399 /B W91-11390 6F	W91-11473 5G
W91-1122	2 5G	W91-11306 5A	W 91-11390 UI	W 21-114/3 30

### ACCESSION NUMBER INDEX

### W91-11474

W91-11474	5D	W91-11506	5B	W91-11538	6E	W91-11570	6B
W91-11475	5B	W91-11507	5A	W91-11539	5D /	W91-11571	2F
W91-11476	5G	W91-11508	5B	W91-11540	5D	W91-11572	2F
W91-11477	5G	W91-11509	5C	W91-11541	5D 9	W91-11573	6E
W91-11478	5D	W91-11510	5E	W91-11542	6E	W91-11574	10D
W91-11479	5D	W91-11511	5D	W91-11543	2G	W91-11575	10D
W91-11480	5D	W91-11512	5D	W91-11544	2J	W91-11576	2E
W91-11481	5D	W91-11513	5A	W91-11545	2E	W91-11577	6E
W91-11482	5D	W91-11514	2H	W91-11546	5B :	W91-11578	2E
W91-11483	5D	W91-11515	2H	W91-11547	5D i	W91-11579	2E
W91-11484	5D	W91-11516	2H	W91-11548	5D	W91-11580	7C
W91-11485	5D	W91-11517	2H	W91-11549	7C	W91-11581	5G
W91-11486	5D	W91-11518	2H	W91-11550	4C	W91-11582	5G
W91-11487	5D	W91-11519	2L	W91-11551	5E	W91-11583	5G
W91-11488	5D	W91-11520	2E	W91-11552	5C	W91-11584	5G
W91-11489	5D	W91-11521	6G	W91-11553	5B		
W91-11490	5D	W91-11522	2E	W91-11554	2F	W91-11585	2E
W91-11491	5D	W91-11523	2H	W91-11555	5A	W91-11586	7B
W91-11492	5D	W91-11524	5C	W91-11556	5G	W91-11587	5B
W91-11493	5D	W91-11525	2H	W91-11557	2L	W91-11588	8C
W91-11494	5D	W91-11526	81	W91-11558	2E	W91-11589	5B
W91-11495	5D	W91-11527	2H	W91-11559	2H	W91-11590	2F
W91-11496	5D	W91-11528	2H	W91-11560	2H	W91-11591	2H
W91-11497	5D	W91-11529	5C	W91-11561	2F	W91-11592	2A
W91-11498	5D	W91-11530	5C	W91-11562	5C	W91-11593	5B
W91-11499	5D	W91-11531	5C	W91-11563	6B	W91-11594	5C
W91-11500	5D	W91-11532	5D	W91-11564	4D	W91-11595	2E
W91-11501	5D	W91-11533	2H	W91-11565	4D	W91-11596	2F
W91-11502	5D	W91-11534	2H	W91-11566	4D	W91-11597	2H
W91-11503	5D	W91-11535	6G	W91-11567	4D	W91-11598	2F
W91-11504	5G	W91-11536	21	W91-11568	4D	W91-11599	5G
W91-11505	5B	W91-11537	5C	W91-11569	6F	W91-11600	5B



### Subject Fields

- NATURE OF WATER
- 4
  - WATER QUALITY MANAGEMENT
- WATER RESOURCES PLANNING
- RESOURCES DATA

#### INDEXES

SUBJECT INDEX

**AUTHOR INDEX** 

**ORGANIZATIONAL INDEX** 

**ACCESSSION NUMBER INDEX** 

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These prices are for customers in the United States, Canada, and Mexico; other customers, write for price list PR-360-4.

#### Microfiche & Paper Copy Reports Computer Products

Standard Prices	Exception Prices	Diskettes	Magnetic Tapes
A01\$9.00	E01\$11	D01\$55	T01\$180
A02 12.50	E0214	D0290	T02240
A03 17.00	E03 16	D03 140	T03360
A04-A05 19.00	E04 19	D04 195	T04480
A06-A09 26.00	E0521	D05250	T05590
A10-A13 35.00	E0624	D06300	T06710
A14-A17 43.00	E0727	D07360	T07 820
A18-A21 50.00	E0830	D08 410	T08 940
A22-A25 59.00	E0933	D09460	T09 1,050
A99	E1036	D10520	T10 1,160
	E1139	D11570	T111.270
	E1243	D12630	T121.390
"N" Codes	E1346	D13 680	T13 1.500
N01\$60.00	E1450	D14740	T141.620
N0259.00	E1554	D15790	T15 1.740
N03 20.00	E16 59	D16840	T16 1,850
1403 20.00	E1764	D17890	T171.960
	E1869	D18 950	T182.080
	E1976	D19 1,000	T192,190
	E2088	D99	T99
	E99		

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